MAY 22, 1961

missiles and rockets

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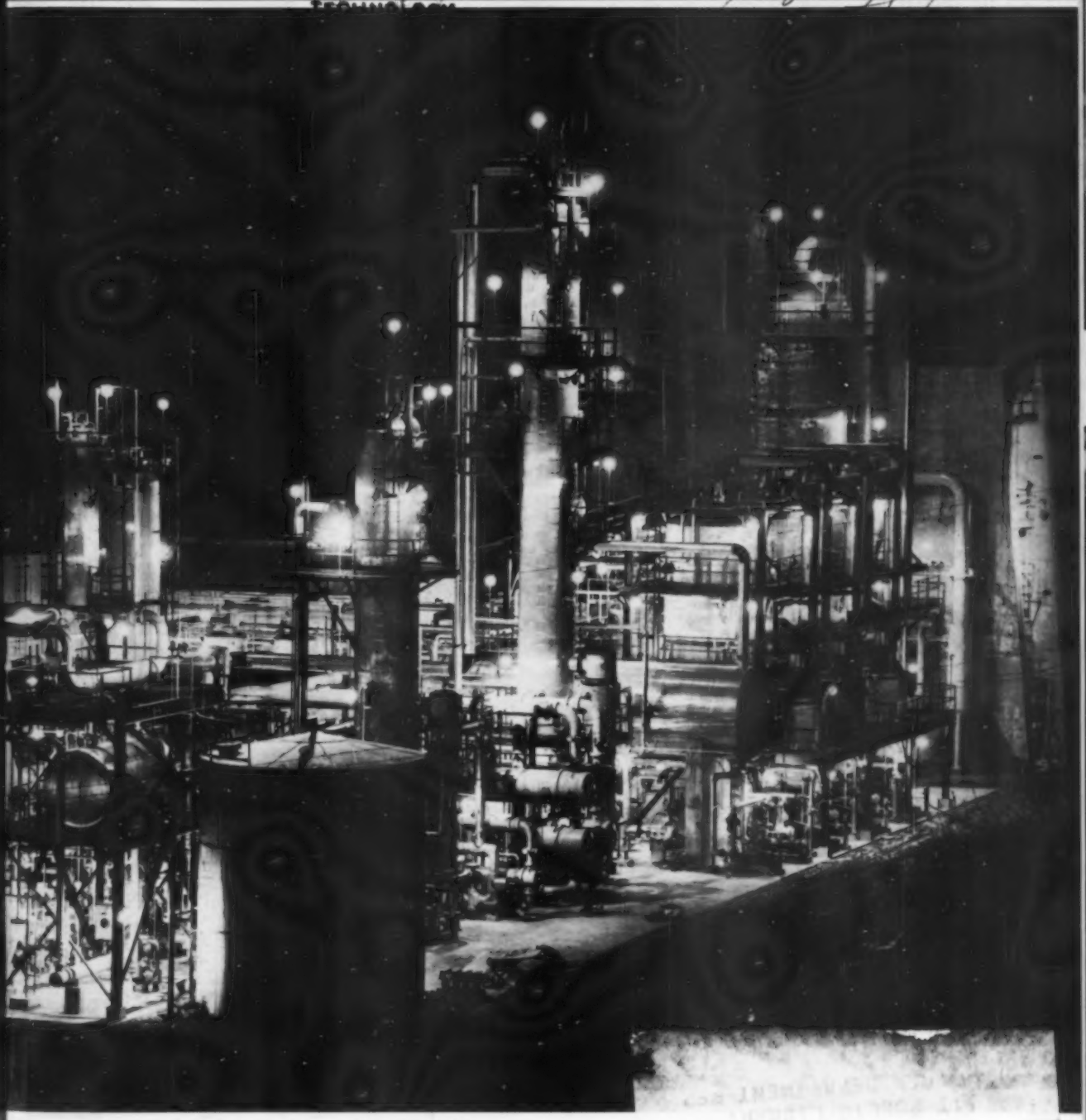
THE MISSILE / SPACE WEEKLY



Olin Anhydrous Hydrazine Plant—World's Biggest

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IR Spectrometer Is Highly Sensitive 30

AN AMERICAN AVIATION PUBLICATION

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Room 803-MR, State Office Bldg., Richmond, Va.
Phone MIlton 4-4111 Ext. 2255

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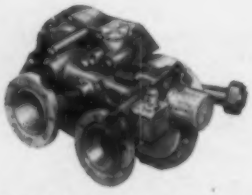
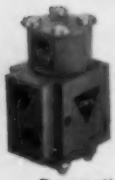

Acid-Aniline Propellant Valve (Corporal Missile)


Pneumatic Actuated Valve (Hound Dog Missile)

Hand Loader (Jupiter Missile)

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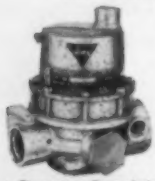
Pressure Regulator (F-104 Interceptor)

Vacuum & Relief Valve (Firebee Drone)

Drain Valve (Constellation Airliner)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THE MISSILE / SPACE WEEKLY

missiles and rockets

Volume 8, Number 21 May 22, 1961

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THE COVER

Largest anhydrous hydrazine plant in the world is now on stream in Saltville, Va. The heavily automated facility will supply fuel for Titan II and Dyna-Soar. See p. 18.

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* U.S. Reg.
† U.S. Reg. Pdg.

34,508 copies this issue

letters

MR-3 Publicity Debated

To the Editor:

A pat on the back for your May 8 editorial, "The Debacle at Cape Canaveral." Of all the editorials that have sprung from the *Mercury* shot, yours was the only one with guts enough to lay it on the line.

In my opinion the people who gained the most from this "lob" downrange were (a) The motels along A-1-A with their full complement of newsmen, home town senators and congressmen; (b) AT&T, Western Union, with their leased wire service—transmitting millions of words to the outside world in regard to what Commander Shepard had for lunch and the local weather report; (c) I would guess the biggest benefit was derived by the vending machines and the chow wagons used to service newsmen waiting for the shot at the grandstand on the Cape.

I just hope your and Senator Williams' advice will be considered on the orbit shot scheduled to come later. However, I doubt it. I would guess they have souvenir pennants all ready—just silk-screen the date, and they will sell like hot cakes, along with the hot dogs, popcorn and cokes.

Robert J. Hughes
Perry-Brown, Inc.
(ex-*Vanguard* Info Team)
Cincinnati

To the Editor:

May I speak personally rather than as a representative of my company? I have just finished reading your editorial, "The Debacle at Cape Canaveral." Happily, the news reports coming in this week from all of the nation's press are proving your editorial to be completely wrong. Apparently world opinion has swung to our side and we actually now have the Russians on the defensive from a propaganda standpoint because of the secrecy of their flight.

Most certainly the flight has proved to have had considerable prestige value and, if my interpretation of what I have read is correct, it also had some scientific value and in effect was a necessary first step to further progress in our space program.

The entire United States felt a great sense of pride in the open and free way our flight was publicized. They also felt a great sense of identity with Commander Shepard.

With major highways running by the Cape, with motels having views of the rockets on their pads, it is difficult for me to see how such an event could be kept secret.

You will pardon me if I consider the words "nauseous," "worst possible taste," "appalling display of ignorance," "buried in an emotional frenzy," "debacle," and "revolting display" hard to take for any of the many thousands of people who have worked so hard to make Project *Mercury* successful.

Dean B. Randall
Minneapolis-Honeywell Regulator Co.
Minneapolis

To the Editor:

In the light of Alan Shepard's high ride to glory, it would be hard to sit down and figure out a more unfortunate headline than you put on your May 8 editorial. However, it is not my intention to belabor you with 20-20 hindsight. My point in writing is this: the *one* thing we *did* have, as it fortunately turned out, which really put the Russians in the shade, was the very thing you were afraid of—the risk, taken in full view of the world. Gagarin might have been Astronaut Number Twenty, for all we know. Or they might have blasted one around, landed it, and planted Gagarin in it after the landing for the cameras.

I *do* think Shepard's ride was more dramatic than anything I have ever seen—that it was handled superbly by the TV boys—that it galvanized this nation (it certainly did me) as no after-the-fact account possibly could. And I further feel that we ought not to follow the secrecy of the Soviets—even if we blow some poor guy to bits on the pad. America is running second—in space, at least—and while you are correct in saying that big public failures are terrible publicity, still, isn't this the strength *and* the weakness of our whole system?

Again, please don't think I'm carping at your editorial. If Shepard had been killed, you'd have had a scoop. I know we are both glad you did not.

Frank Harvey
Hackettstown, N. J.

To the Editor:

The editorial is the meanest and most shameful criticism and ridicule of a great American hero ever printed. This reads like communism, so please cancel my subscription.

Dewey Thompson
Washington

To the Editor:

Without question, Mr. Coughlin. . . .

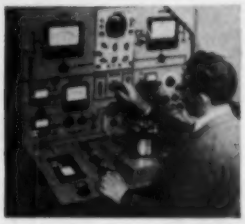
Your editorial is a beaut! We're not surprised to find the sentiments you expressed in MISSILE AND ROCKETS; it takes an editorial and a publishing staff with wisdom and courage to put into black and white the thoughts that many of us have nourished privately. This one editorial alone is worth the price of the subscriptions!

Lucien R. Greif
Greif Associates, Inc.
New York

To the Editor:

Your editorial, with its clichés and witticisms, was not in character with your fine publication. You state that yours is

Very High Production Standards



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not to question the courage and dedication of the Project *Mercury* team, but to question the wisdom of the public relations approach to the shot. If this is true, why do you call this suborbital launch a "Circus Stunt," a "Roman Spectacle," a "Debacle," a "Human Cannon-Ball" fired before the eyes of horrified paying customers?

Sure there was an element of risk, but isn't this always true in exploration? I was not nauseated by this "revolting" display, I was proud. Proud and humble at the same time, realizing that this was the culmination of many, many man-hours of hard work and the answer to unnumbered prayers.

I suggest that to have handled the publicity in any other manner would have had a tendency to discredit the effort as a whole. The world has been impressed with two cogent facts: (1) We did send a man into space and successfully recover him with no apparent ill effects and (2) a human life is still the most important commodity in the U.S.

We learn from our failures and we are proud of our successes.

T. W. Wissore
Chesterfield, Mo.

To the Editor:

I do not share the view expressed in your very critical editorial. Bold action was required to get the most favorable world reaction to what was admittedly a minor feat compared to Major Gagarin's flight. It was a gamble which in my opinion was well taken and which paid off.

If the flight had failed, a critical editorial would probably have drawn assent from many readers. I admire your courage in presenting the negative view . . .

H. F. Mayer
Manager, Advanced Electronics Center
General Electric Co.
Ithaca, N.Y.

To the Editor:

A California orchid to Bill Coughlin for the perspicacity and courage that impelled him to publish the only forthright editorial on the subject of "the debacle at Cape Canaveral" that I have read anywhere—and I have done some looking.

I would like to go on for several paragraphs venting my own views on that pathetic vaudeville performance, but Bill wrote it better and with gentlemanly restraint, so I will choke off my own choler.

I am having the piece copied and sending it out to encourage some friends in public places to think with their thinkers instead of their feelers.

Bert W. Holloway
Corporate Director
Advertising, Publicity, Promotion
Lockheed Aircraft Corp.
Burbank, Calif.

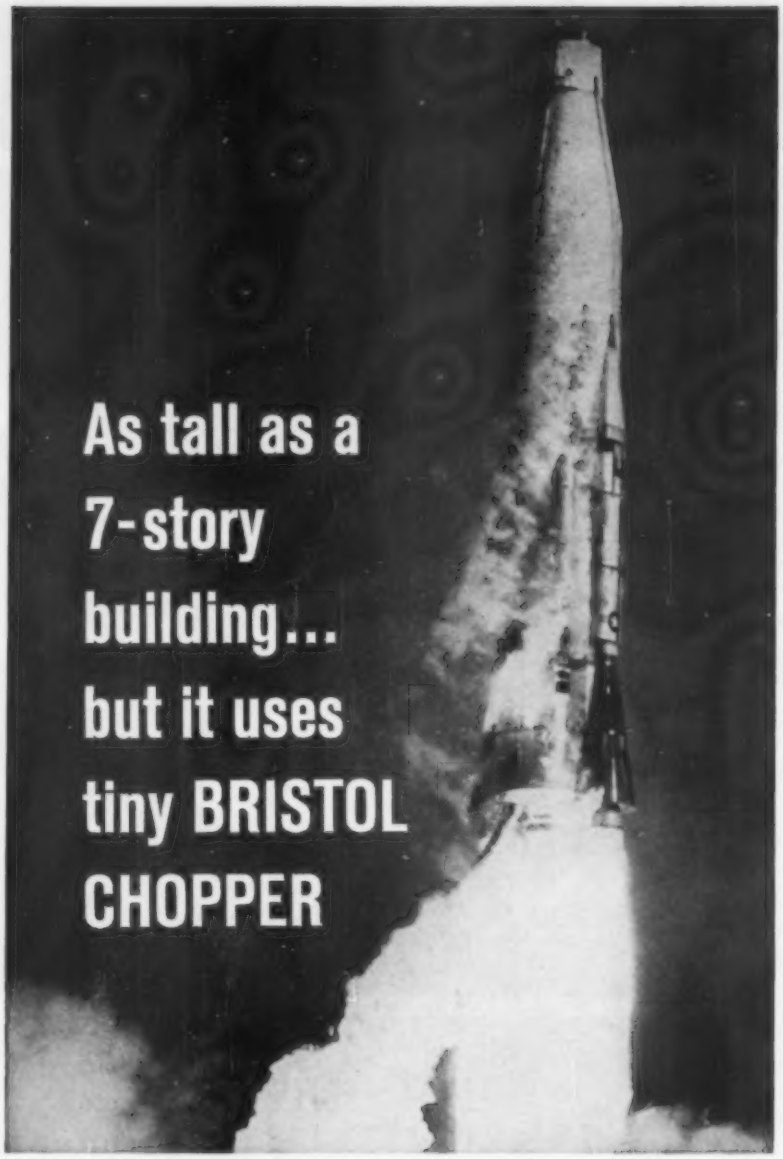
Telling the People

To the Editor:

Re your editorial (M/R, May 1), "The People Wait to be Told."

Amen!

Harrison A. Lehmann
Major, USAF
Eau Gallie, Fla.



More than 40,000 parts, each of which must meet the most stringent reliability standards, make up the U. S. *Atlas* intercontinental ballistic missile, built by prime contractor Convair (Astronautics) Division, General Dynamics Corporation.

Among these parts is the Bristol Syncroverter* chopper . . . adding to its record of service in U. S. guided missile systems of almost every type since their very beginnings.

Billions of operations. To insure the reliability so necessary in aircraft and missile operations, Bristol Syncroverter choppers are constantly under test at Bristol, with and without contact load. One example: We've had five 400-cycle choppers operating with 12v, 1ma. resistive contact load, for more than 26,000 hours (2.96 years) *continuously* without failure—over 37-billion operations!

Many variations of Bristol Syncroverter choppers and high-speed relays are available—including external-coil, low-noise choppers. Write for full data. The Bristol Company, Aircraft Equipment Division, 173 Bristol Road, Waterbury 20, Conn.

actual size

*T. M. Reg. U. S. Pat. Off.

BRISTOL FINE PRECISION INSTRUMENTS FOR OVER SEVENTY YEARS

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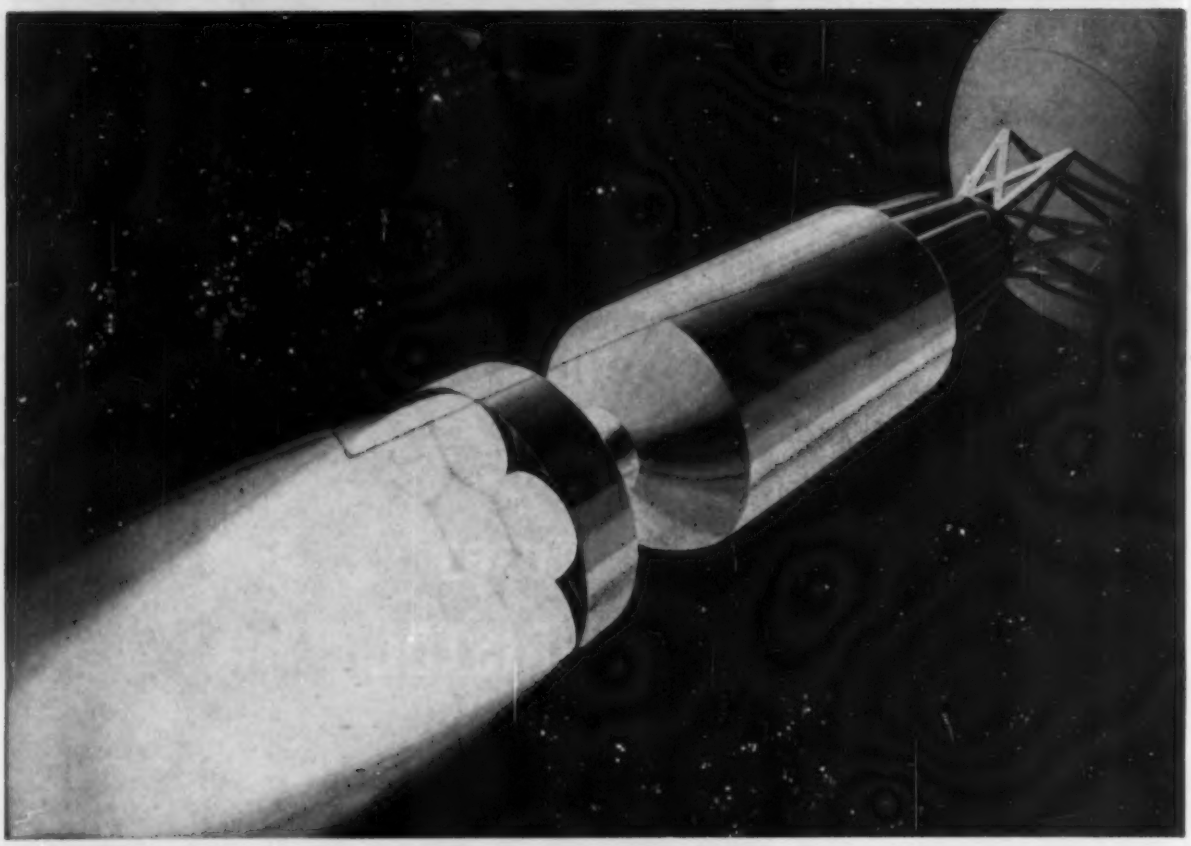
NUCLEAR ROCKET PROPULSION AT AEROJET-GENERAL



Nuclear rockets, with a performance capability nearly twice that of the highest-specific-impulse chemical rockets, have been of major interest to Aerojet-General for several years.

Exploratory studies were initiated by Aerojet in 1955 to ascertain the feasibility of nuclear rockets, and the technical advances required to develop a successful nuclear propulsion system were determined. This work at Aerojet has undergone continuous expansion under government and company sponsored programs. Included are: preliminary design of engines and vehicles, simulated nuclear engine tests, radiation hazards research, analog computer system design (to simulate nuclear rocket operation), nuclear test facility construction, and the design, development, testing, and manufacture of reactors.

These programs have resulted in significant progress toward the development of a practical and reliable nuclear propulsion system. They are based on Aerojet's combined experience in liquid and solid propellant rocketry, nuclear technology, and cryogenics—experience which ensures that the challenge of a new era in propulsion can, and will, be met.

CORPORATION

THE GENERAL TIRE

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The Countdown

WASHINGTON

Where the AF Missile Dollar Will Go . . .

The latest revision of the Air Force procurement program for missiles in FY '62 includes: $201.6 million for Convair *Atlases*; $1.13 billion for Martin *Titans*; $923.8 million for Boeing *Minutemen*; $131 million for North American *Hound Dogs;* and $16.3 million for Martin *Bullpups*.

And the Navy's . . .

The new Navy's FY '62 missile procurement program includes: $37.8 million for Raytheon *Sparrow III's*; $25.2 million for *Sidewinder 1-C's;* $45.3 million for Convair *Tartars*; $36.8 million for Bendix *Taloses*; $26.2 million for *Bullpups*; and $6.7 million for the initial buy of Goodyear *Subrocs*.

And the Army's . . .

The new Army FY '62 missile procurement program includes: $78 million for *Nike-Hercules* GSE; $127.7 million for Raytheon *Hawks;* $9.8 million for Nord *Entacs*; $16.7 million for Emerson Electric *Honest Johns*; $93 million for Sperry *Sergeants*.

New Polaris Increase Voted Down

The House Armed Services Committee voted down in closed session a committee member's proposal to add six more *Polaris* subs to the 10 included by President Kennedy in the FY '62 defense budget. The Kennedy request would bring the total number of *Polaris* submarines authorized by Congress to 29. The additional six were proposed to enable the Navy to build more long-leadtime items—and to tentatively commit the Administration to building more than 29 *Polaris* subs. The committee vote: 25 to 3.

The Coming Boost for Boosters

Both nuclear-powered and solid-propelled boosters are expected to receive a major push in President Kennedy's forthcoming request for greater space spending. Insiders predict the Air Force will be given the assignment to develop a large segmented solid booster; NASA and the AEC will continue work on *Rover*. This would be the first major switch in booster assignment since NASA was given the National Booster Program.

Total Subroc Buy Disclosed

The Navy has revealed that it plans to spend a total of $100 million on the new *Subroc* ASW missile. The nuclear-tipped Goodyear missile is expected to be deployed for the first time this year, greatly extending the striking range of U.S. hunter-killer submarines.

Weather Satellite Net: Coming Soon

The Kennedy Administration is expected to put more money behind development of a weather satellite network that possibly could be in operation by mid-1962. Under plans now being discussed, the Weather Bureau would have operational control; NASA would provide the satellites and boosters and direct satellite launchings.

INDUSTRY

New ICBM Contract Probe Under Way

The House Armed Services Investigating Subcommittee is digging into charges that bid "procuring" is again infecting the ICBM base-construction program. This time the first *Minuteman* complex in Montana is involved. Allegedly two Los Angeles firms—George A. Fuller and Del E. Webb Corp.—received a $61-million contract and proceeded to subcontract almost all of it. Then, allegedly, almost all of the subcontractors proceeded to do the same.

R&D Intelligence

AEC is talking again about the possibility of flight-testing a *Rover* nuclear rocket engine by 1965—if all technical milestones are reached. . . . MIT's National Magnet Laboratory will be equipped with air-core magnets developing 250,000 gauss, a half-million times greater than the earth's magnetic field. General Electric is supplying the power sets (8000 kw) under a $1-million contract. . . . AOMC is building a new test facility at Huntsville to captive-fire *Nike-Zeus* and other solid missiles.

Titan II First Flight Now '62

COUNTDOWN is told the first flight of the storable *Titan II* test is now expected to slip over into early 1962. The official schedule has a date late this year.

C-W Moving Into Missile/Space Field

Curtis-Wright Corp. is beefing up its electronic and nuclear capability—apparently in preparation for a major corporate move into the missile/space industry. C-W has just purchased Abrams Instrument Corp. (electronics) and set up a new subsidiary, Advanced Miniaturized Electronics Inc. It also has bought into Target Rock Corp., a nuclear power component maker.

Big Atlas-Agena B Buy Forecast

Grand Central Rocket Co. estimates predict the Air Force will buy 265 *Atlas-Agena B's* in the next 10 years for four satellite programs alone. The GCR count: 84 for *Samos*, 56 for *Saint*, 83 for *Midas* and 42 for *Bambi*.

INTERNATIONAL

Overseas Pipeline

Russia is expected in some quarters to launch another spacecraft soon—this time with two men inside. . . . Canada is interested in buying *Bomarc B* antiaircraft missiles armed with nuclear warheads. . . . Insiders are wondering why the Red Chinese are taking so long to touch off their first nuclear device. It was expected earlier this year. There is a possibility the Russians prevailed upon them to postpone the shot to strengthen the case for the United States to pressure the French into curtailing their A-tests.

Turkey Talk on Blue Water

British Defense Minister Harold Watkinson is understood to be talking turkey with the West Germans about the merits of buying the British *Blue Water* rather than the U.S. *Sergeant*.

SUPPORT FOR THE SPACE AGE

Since the early days of "wireless" Blaw-Knox has been designing, fabricating and erecting towers and special structures to support equipment used to penetrate space. This long experience with the problems involved in this field is the reason systems companies and governmental agencies continue to utilize Blaw-Knox specialized facilities.

Call Blaw-Knox early in the planning stages for consultation and assistance on the design and fabrication of either prototype or production items. Blaw-Knox Company, Pittsburgh 38, Pennsylvania.

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The Missile/Space Week

Moon Investigation Sought

A member of the House Space Committee has called for a congressional investigation into the scientific and strategic importance of the moon.

Rep. David S. King (D-Utah) urged the inquiry in a letter to Committee Chairman Overton Brooks on the grounds that "neither Congress nor the American public fully understands the importance of beating the Russians to the moon."

Meantime, the committee released a staff study contending that military needs in space are being shortchanged.

The study—written last December—urged the creation of a top-level management agency under the National Space Council. It also urged the creation of a military applications division within the National Aeronautics and Space Administration.

Grind for Astronauts

A six-month course at the Air Force's new space pilot school could be the most grueling in an aspiring astronaut's life.

Enrollees, already graduates of the eight-month Experimental Flight Test Pilot School Course, must master Newtonian mechanics, thermodynamics, fluid mechanics, boundary layer theory, high-speed aerodynamics, heat transfer, dynamics of rarified gases, Einstein's theory of relativity, meteorology, astronomy, propulsion, orbital mechanics, trajectories and other subjects.

Several T-38's and F-104's will be modified to provide spacecraft flight characteristics. AFSC is also considering modifying an *X-15* to make a two-seat trainer. The school will be conducted at the Air Force Flight Test Center, Edwards AFB, Calif.

S-II Deadline Nears

Seven companies are still in the running for the prime contract on the *Saturn S-II* stage, which will be the largest rocket ever built by private industry, at a total cost of $220 to $240 million.

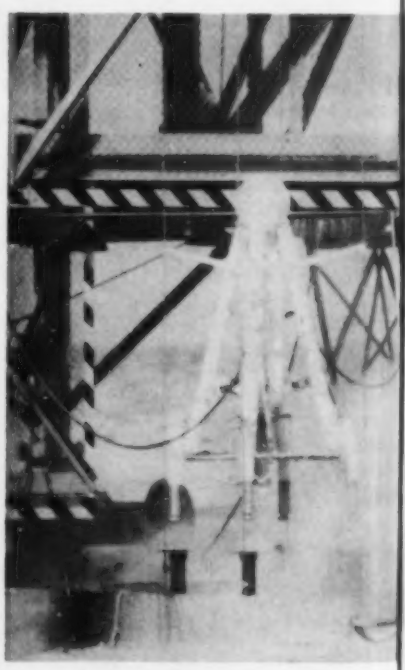
Aerojet-General, Chrysler Missile Division, Convair/Astronautics, Douglas, Lockheed Georgia Division, Martin-Baltimore and North American-Los Angeles filed preliminary proposals with the National Aeronautics and Space Administration earlier this month.

In about two weeks, NASA's Marshall Space Flight Center will invite some or all of the seven to submit detailed bids with cost information. The deadline has not yet been set. The bids will be evaluated in time to award the contract soon after the July 1 beginning of the new fiscal year.

President Kennedy has ordered NASA to move at top speed starting work on the *S-II*, which will be the second stage of *Saturn C-2*, the launch vehicle designed for manned circumlunar flight.

Atlas Boosters Modified

Atlas boosters to be used for the unmanned and manned Project *Mercury* orbital flights are "ready to go" as far as modifications are concerned. Convair/Astronautics spokesmen say



Moon Soft-Lander?

700-LB. rocket-powered vehicle developed by Navy can reverse thrust and land softly. NOTS engine has 1300-lb. thrust.

the programer trouble blamed for the last *Atlas* launch failure has been corrected with "several design changes" now undergoing checkout.

Karel J. Bossart, Convair/Astronautics technical director, said the major modification NASA originally asked for involved thickening of the nose section skin, "although we didn't think this was essential."

Bossart expressed concern over what he called recent erroneous newspaper reports that the *Atlas* booster was to blame for some launch failures. "The *Atlas* isn't entirely blameless," he said. "But it should be pointed out that some of the 'failures' were in the second-stage missile, not the booster."

Final Tests for SA-1

In about a week, the *SA-1 Saturn* flight booster will come down from the static test stand at Huntsville and go into quality control for final testing.

The booster passed its final static test May 11 in a 111-sec. firing. It will be in quality control for about 2½ months and then will be prepared for shipment to Cape Canaveral. Flight date is expected to be October.

The contractors will turn over the launch tower at the Cape to NASA on June 5.

Earth-Moon Transport Study

The Martin Co. will study an earth-lunar transportation system for NASA under a $75,000 contract with Marshall Space Flight Center.

The study will cover the problems of lunar landing and immediate return, a 30-day stay and a permanent lunar base.

Bouncing Off Venus

Russia has measured the astronomical unit at 149,457,000 kilometers (92.9 million miles) by radar reflection from Venus.

Tass quoted the USSR Academy of Sciences last week as reporting that the radar reflections showed the planet's period of rotation to be about 10 or 11 days.

In the United States, the Jet Propulsion Laboratory of the California Institute of Technology also made measurements by radar during Venus' recent close approach. However, the JPL results have not yet been reported.

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Blue Water unveiling . . .

British Push Tactical Missile

English Electric bird competes hard against Sperry's Sergeant, is main attraction among missiles at Paris Show

by Bernard Poirier

English Electric is publicly displaying its secret *Blue Water* missile for the first time this week in a stepped-up drive in the NATO nations to outsell the competing Sperry *Sergeant*.

The showing of the solid-propellant surface-to-surface *Blue Water* at the Paris Air Show comes as the Anglo-American sales fight reaches a new level of bitterness in diplomatic and British industry circles.

Meantime, the West German missile market appeared to be opening up. They are now in the process of buying the 350-mile *Pershing* and weighing purchases of other missiles.

West German Defense Minister Franz Josef Strauss stressed anew his belief in the need for a credible nuclear deterrent force in Europe and indicated strongly that West Germany might have to take new steps to maintain one.

Blue Water represents Britain's initial public bid to answer SACEUR's proposal to make "battlefield-type atomic weapons" available to battalion size NATO units of some 4000 men each.

• **Short countdown** — The *Blue Water* combat unit includes only a Bedford launcher and a Land Rover computer van. Miscellaneous equipment like the tripod theodolite, cables and manual controls are carried along with the crew in the vehicles.

The offer of a flexible and lethal weapon to NATO comes at a time when most military commanders agree with SACEUR's appraisal that in reasonable circumstances "the forces assigned to NATO require the support of nuclear weapons."

English Electric, a British Aircraft Corp. member, admits potential launching sites should be surveyed beforehand. Short 10 min. countdowns are possible when "the actual firing site has already been accurately surveyed." Reportedly NATO has surveyed all areas where enemy aggression could likely occur from the North Sea to the Adriatic.

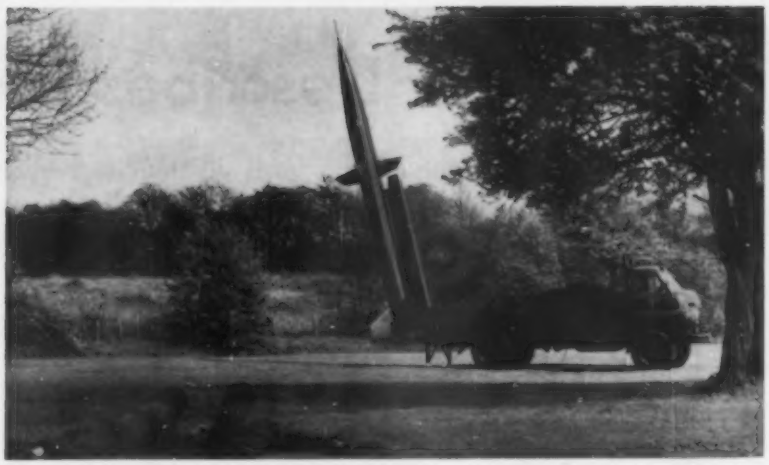
The compact field unit is self-sufficient. It carries target information, computers, circuits and cables to activate guidance and firing sequences. The short firing time is possibly unequalled by any other known or admitted land system.

Relatively lightweight, the 25-ft. missile is carried on a 3-ton chassis. The missile carrier can remain hidden while the crew and computer van are at the site preparing for launch. The company suggests the interval from the time the crew reaches the launch site to the programmed air burst of the warhead is about 15 mins.

Pleased by evaluation tests over the last six months (believed to have been conducted at Woomera), they say no anomalies in solid motors were discovered after storage tests and that assigned missiles "can be kept for long periods of instant readiness."

• **70 mi. range reported**—Chief competitor to *Blue Water* is the American *Sergeant* manufactured by Sperry Utah Engineering Lab. Their ranges are believed to be comparable although the *Sergeant* is 11 ft. longer than its rival to replace *Corporal*. (M/R, Oct. 17, 1960, p. 41).

The British bid to offer a missile with nuclear capabilities to NATO could dissipate much of the political controversy that so far has stalled establishing NATO as the fifth nuclear



OPTICAL ALIGNMENT with theodolite of stable platform is done while Blue Water is in horizontal position. About 30 missiles have been test-fired. Model shown here is dummy of operational configuration, which is 25 ft. long.

ile Sales to NATO Nations

power. Standardization and agreement on this doctrine would serve to hone the NATO sword and increase credibility of its continental shield.

West Germany has been supporting the idea of NATO participation in sharing *Blue Water* T&E costs and possibly cutting its operational 1963 target date. Moreover, non-NATO member Sweden has officially expressed interest in the missile's dual purpose of conventional or atomic capability.

English Electric's entry into NATO competition appears strong as judged by details of combat countdown procedure which will be demonstrated in Paris by a British Army detachment from the Royal Artillery. This is the sequence:

• **T−13 mins.**—Computer van reaches the site and calculates reciprocal target bearing which is relayed to the theodolite operator who then positions directional markers for the launcher's driver.

• **T−12 mins.**—Launcher moves on site as computer in van refines azimuth and target bearing. Theodolite telescope is set at 90° to this bearing.

• **T−11 mins.**—Rear of launcher platform is levelled transversely with jack extensions.

• **T−10 mins.**—Computer van draws alongside for multicore cable connection with launcher fire control. Flight instructions and target selection are fed to missile guidance through relay.

• **T−8 mins.**—Unsecure transportation clamps. Release stable inertial platform in missile while crew extends firing cable away from launcher to command area.

• **T−6 mins.**—Check-out firing and guidance circuits while nozzle and ignitor is attached.

• **T−4 mins.**—The theodolite operator, looking through the theodolite into a window in the skin of the missile, uses a remote control box to align the stabilized platform and nul any drift.

• **T−2 mins.**—All gear except fire cable and firing switch unit is packed away. The officer activates the warhead safety switch and joins an enlisted man who readies the firing circuit. Van and remaining crew drive off to a second launching site.

• **T−1 min.**—Goes on internal and boom elevates automatically to firing position. On go.

• **T+2 mins.**—Launcher departs to reloading area.

• **T+2½ mins.**—Air burst over target area. ¤

COMPACT SYSTEM is scheduled to be operational in 1963, after more tests

Before House group . . .

Marquardt Describes LACE, NULACE

Developer claims high efficiencies for engines aimed at use in Aerospace Plane—hybridization enhances overall performance

FIRST DETAILS of the liquid air cycle engine (LACE) and nuclear liquid air cycle engine (NULACE) under development by Marquardt Corp. for possible Aerospace Plane applications have been released by the House Space Committee.

Testimony on the engines was presented to the committee during its March hearings on space propulsion technology.

Marquardt has been developing critical components and technology for LACE under an Air Force-sponsored program.

The company described LACE as an engine which employs the refrigerating capability of liquid hydrogen to cool and liquefy air from the atmosphere. This liquid air then is pumped into a rocket thrust chamber and burned with the hydrogen used to liquefy it.

"There are many advantages in an engine of this type, as study of its installation in an aircraft in combination with ramjet engines will reveal," the company said. "We can point out here that pumping the air as a liquid results in a reduction in size and weight of propulsion machinery over any other air-handling devices."

The company told the committee in its written testimony that the extension of aircraft operations into space is considered by Marquardt as the most probable way in which routine, reliable and economical operations in space will come about.

It said the earliest of the Aerospace Plane-type vehicles is expected to exhibit almost a two-fold gain in the fraction of weight in orbit over rocket-boosted vehicles of the same time period. LACE was described as several times more efficient than the chemical rocket engine.

NULACE, the nuclear version of LACE, was said to be more efficient than the *Rover* nuclear rocket engine.

"As with *Rover*," Marquardt reported, NULACE will require more development before its availability will equal that of chemical air-breathing engines. Nevertheless, the promise of the nuclear orbital airplane is great. . . ."

• **Happy wedding**—NULACE is a hybridization of the nuclear rocket with LACE. Noting that hybridization of two powerplants frequently results in only physical combining of the engines with no overall performance gain, Marquardt asserted that the NULACE combination results in performance much greater than that of either alone.

"Uniquely, the performances of LACE and nuclear rocket are additive in this hybridization, almost without parallel in propulsion concepts," it said. Specific impulses more than twice those of *Rover* were said to be attainable.

The report noted that an orbital aircraft could take off on initial boost from the ground without operation of the nuclear reactor, thereby eliminating ground radiation hazards.

"Even without the reactor operating, NULACE is capable of higher specific impulses than *Rover*," the company said. After reaching a safe altitude, the vehicle's reactor then would be started to attain the full performance potential of NULACE.

On departure from the atmosphere, the air-breathing portion of the orbital aircraft's NULACE engine would be shut down for operation as a conventional nuclear rocket.

Marquardt said the size of the reactor required for NULACE in an orbital airplane is several times smaller than the reactor required for *Rover* to deliver equal payloads into space.

The report said development of NULACE depends upon development of both LACE and *Rover* but no major technological breakthrough appears necessary.

General Electric and Pratt & Whitney are known to be developing similar engines for Aerospace Plane application, but no details were released. ⁂

Thiokol Wins Contract for 3rd-Stage Dyna-Soar Motor

THE BOEING CO. has awarded a multimillion-dollar subcontract to Thiokol Chemical Corp. Elkton Division for a solid-fueled third-stage accelerator/escape rocket in the Dyna-Soar system.

Described as a "foreshortened Minuteman second stage," the 60,000-lb.-thrust motor will be designed to provide additional thrust for the Dyna-Soar glider or act as the escape propulsion system in the event of a failure during launch (M/R, March 6, p. 12).

The contract—one of the largest yet awarded in the program—calls for design, development, test and manufacture of the motor.

Boeing said it is buying a package from Thiokol consisting of the nozzles, thrust vector control system, igniter system and propellant. The motor probably will not be used on the initial subsonic glider drop tests from aircraft at Edwards AFB, Calif., during pilot familiarization and landing studies. However, it will be fired in later drop tests to check supersonic performance.

While the contract may run to several million, no dollar figure was given. Nor was the number of rocket motors mentioned.

Boeing last week also awarded a major subcontract to Electro-Mechanical Research Inc. for development of the Dyna-Soar test instrumentation subsystem. The amount was not revealed. But industry sources expect the complete data system will cost close to $12 million.

EMR will provide both airborne and ground equipment for collecting and processing test data.

Airborne equipment will include both PCM (pulse-code modulation) and FM (frequency modulated) conversion equipment, a time-coded generator, and a tape recorder for data storage. Ground systems will include equipment for receiving, recording, processing, and displaying.

The communication and data link subsystem—to transmit collected information from the vehicle to the ground—will be developed by RCA, Dyna-Soar associate contractor.

Follow-on a-building . . .

Troy IIA-1 Run Aids Pluto Outlook

by Frank G. McGuire

JACKASS FLATS, NEV.—A successful first power run of the *Tory IIA-1* test reactor has given a boost to the joint Air Force-Atomic Energy Commission Project *Pluto*—the nuclear ramjet engine development program.

The reactor was operated May 14 at approximately 25% of the 150-thermal-megawatt maximum design power for 45 seconds.

The power run was held off two days due to strong winds, despite presence of nine congressmen and a number of top USAF officials. AEC was fearful of uncontrollable fallout patterns due to the winds.

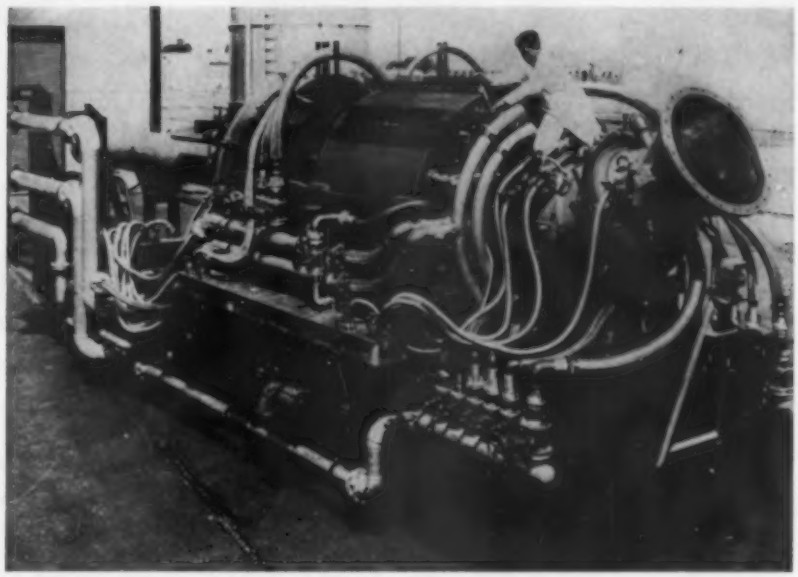
The 40-thermal-megawatt run was intended to demonstrate the engineering feasibility of the core design. Under development by the Livermore Radiation Laboratory of the University of California, *Tory IIA-1* operated at temperatures well in excess of 2000°F. Exact temperatures were classified.

• **Days to hours**—An interesting switch in terminology for the Supersonic Low Altitude Missile *(SLAM)*, which utilizes a nuclear ramjet, was noted. Brig. Gen. Irving Branch, responsible, for the program, stated last December that a *SLAM*-type vehicle could operate "for several days." (M/R, Dec. 19, 1960, p. 16.) The Air Force now says such a vehicle could operate at Mach 3 "for several hours."

AEC officials say the factor limiting flight duration will be the ability to retain the fuel elements within the core. Flight stresses will cause high erosion rates and fuel element ejection from the exhaust nozzle. Materials with long-duration resistance to high heat levels are also expected to be a problem.

The recent test was initially planned for January, but had to be postponed to allow repair of rail car and test bunker couplings which were damaged when the rail car accidentally rolled down an incline into the concrete bunker.

Pluto, now the major project in the Air Force's aircraft nuclear propulsion office, will provide power for the *SLAM*, a program to create a "suspense missile" capable of long-duration aerial patrol similar to that now provided by B-52 bombers. In this application, it may well do the job assigned the ill-fated nuclear-powered aircraft but at lower cost, due to reduction of shielding problems.



TORY IIA EXPERIMENTAL REACTOR appears all but buried in a maze of cooling pipes and air passages. The massive graphite reflectors behind the technician cover the core vessel to block escaping neutrons.

Tory IIA-1 is a direct-cycle, air-cooled reactor using fuel elements of highly-enriched uranium homogeneously mixed with beryllium oxide. Its backup reactor, designated *Tory IIA-2*, is similar in all respects except fuel elements design. *Tory IIA-1* elements number 100,000 and the AEC originally placed its operating temperature at 2300°F. The core measures 30 in. in diameter and 45 in. long, with half the cross-section being void to allow air passage. Each fuel element is a hexagonal rod 4 in. long and ¼ in. across the flats. A $\frac{1}{50}$-in. hole is longitudinally located in the center.

The problem of core retention centers around the 100,000 lbs. pressure exerted on the face of the reactor during operation. The support structure must contain this pressure at 2300°F and in a high-radiation field. The core is surrounded by a graphite reflector to aid in the nutronics of the design, since the core itself is not large enough to sustain a chain reaction. The escape of neutrons is hindered by the reflector, sustaining a reaction.

• **New fuel contract**—LRL is concurrently developing a follow-on reactor for the *Pluto* program—the *Tory IIC*, an advanced design of classified configuration. Hardware is currently being fabricated and the fuel elements will be made under a $4.29-million contract awarded to Coors Porcelain Co. by Lawrence Radiation Laboratory. The fuel will be enriched urania-beryllia.

Tory IIC will have a more streamlined configuration. The air supply at the flats will be increased from the current 120,000 lbs. to about 1.2 million lbs. for subsequent reactor tests. ⌗

Test Sequence

First run of the *Tory IIA-1* followed this general countdown sequence:

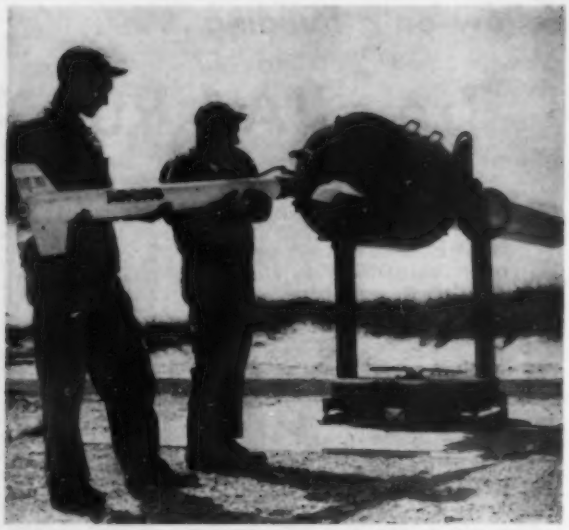
Arm air supply. Start light water pumps. Close reflectors to 6 in. Start heavy water pumps. Verify that reactor is in the "scram" mode. Start control system hydraulic pump. Close reflectors. Begin approach on critical standard start procedure.

Arm automatic control system. Transfer to log power automatic control. Increase nuclear power until pre-planned core temperature is reached. Start strain gage recorders.

Increase power until maximum pre-planned core temperature is reached. Hold for 45 secs. and decrease temperature to former level.

Stop strain gage recorders. Transfer to manual servo. Run in all vanes and control rods. Scram reactor. Withdraw reflectors. Secure heavy water pumps.

ROBIN NOSE CONE is attached to Arcas booster rocket at Eglin AFB by S/Sgt. Seddon Whatmough Jr. and A/2C Elston Brooks.



SIMPLE PROCESS of loading Arcas-Robin into launcher is demonstrated by S/Sgts. Robert Basins and Charles Herron.

Weather Rockets Fired One-an-Hour

AIMING SKYWARD, Basins and Herron prepare to launch Arcas-Robin. Eglin AFB fired 24 on an hourly basis May 9-10.

Record set by Eglin crews with Arcas-Robin systems used to collect data on upper atmosphere, train weathermen

THE AIR PROVING Ground Center at Eglin AFB, Fla., set a record May 9 and 10 by launching 24 weather sounding rockets in 24 hours.

The rockets were *Arcas-Robins*, designed to obtain meteorological information from the stratosphere in the region between 16 and 45 miles altitude.

The 8-ft. *Arcas*, manufactured by Atlantic Research Corp., carries an 8½-lb. payload, including a balloon that inflates at 225,000 ft. and remains inflated until it falls to about 90,000 ft.

The first of the rockets was launched from the APGC facility at Santa Rosa Island at 6:30 p.m. May 9. One rocket was launched every 60 minutes until the next day.

The program serves a dual purpose. Information is obtained on upper atmosphere weather conditions and U.S. weather personnel are being trained to develop an operational rocketsonde system. The program began last Oct. 11 and will be completed this month.

Later this year, an additional 100 *Arcas-Robin* systems are to be launched from Santa Rosa Island with modified payloads.

Eventually, the U.S. weather services hope to establish a network of rocket-launching sites across the country to obtain coordinated data on stratosphere conditions on a regular basis. In addition to existing launch sites operated by the military services and the National Aeronautics and Space Administration, there are proposals to set up one or more facilities in the midcontinent area.

The greatest need for the high-altitude weather data has developed with high-altitude jet transport flight. ⌗

ROBIN BALLOON, which inflates at altitude after launching by Arcas, is examined by scientists at Air Proving Ground.

Communication satellites . . .

Business in Billions Is Forecast

***WORLDWIDE** communications by satellite is expected to be one of the earliest and most profitable commercial uses of space. But there are many problems still to be solved. George J. Feldman—former director and chief counsel of the Select House Space Committee, a principal author of the National Space Act and a well-known New York corporation lawyer—has studied these problems for many years. At this time when communications satellites are more than ever a subject of national and international interest, Feldman has written a comprehensive survey of the subject for* MISSILES AND ROCKETS. *—Ed.*

by George J. Feldman

THE COMMUNICATIONS satellite promises to be the earliest big money payoff from space exploration.

Within the next few years, communication by satellite could easily become a multibillion-dollar business. Within 10 to 15 years, the communication satellite business could well become a $100-billion-a-year business.

Moreover, communication satellites promise to be the first form of space technology to enter our daily lives and revolutionize our ways of doing business.

Thus it is important to see just what communication satellites can do for us and to look at the many associated problems that we are going to have to face.

To begin with, why do we need communication satellites?

• **Capacity**—They would permit the long-range transmission of higher frequencies (traveling in straight lines), and therefore could provide a great number of additional channels for long-range telephone, telegraph, radio and television service. Microwave channels already in use are badly congested, and the demand is rising rapidly. In 1960, for example, some 3 million overseas telephone calls were made or received in the United States. The number is expected to reach 21 million by 1970, and 100 million by 1980.

The rapid growth of technology and population all over the world is threatening the continued use of frequencies that Western countries have had to themselves. Also, the exploration of outer space will increasingly demand reliable communications between space vehicles and ground stations. Some of the very early practical applications of space technology—notably for weather forecasting, navigation and surveillance—will also utilize wide bands of radio frequencies for communications.

Satellites offer the only known way to meet this expected increase in demand. A system of two earth-synchronous satellites could provide some 2,000 more telephone channels, compared to only 100 or so for an underwater cable.

• **Reliability**—According to current estimates, satellite communication systems will prove to be more reliable than either cable or radio links. For example, they will not be subject to interference by sunspot activity or the cutting of underwater cables.

• **Costs**—Will communication satellites give the first answer to the question, "How can you make a buck in space?" They probably will. It is still hard to estimate the costs, partly because they depend so much on the useful life of the satellite components. The minimum economical life of a communication satellite is about one year. Most cost estimates assume an expected life of about five years.

According to some estimates, an active low-orbit system would cost about $150 million initially and $10 million a year to operate. A system with 3 stationary (24-hour) satellites might cost twice as much. At present rates, gross revenues from a 1000-channel telephone system would amount to nearly $100 million a year. From estimates like these, it appears that satellite communications will be profitable at least by 1970. Initial costs could probably be paid off within a decade.

Consumers will benefit, too. It is believed that the cost of satellite communications per voice-channel mile will eventually be lower than that of present long-range communications systems.

Satellites are expected to be useful in military as well as civilian communications, mainly for reasons of capacity, reliability and security. In remote or undeveloped regions, furthermore, satellite relays can be set up quickly, while conventional long-range communication systems may take years to complete.

• **Thorns in the path**—What policy problems will satellite communications create? At this stage of history we can give only a partial list.

• **Frequency allocation and use**—Almost everyone agrees that early international allocation and domestic assignment of channels are needed for earth-space service and for radio astronomy. An international agreement will obviously be required, but may be difficult to negotiate.

International microwave communications will also raise the problem of equipment compatibility, particularly for television broadcasts.

• **Sharing of benefits and costs**—Another problem will be the sharing of benefits and costs (a) among governments and (b) between governments and private users. For example, who will pay for what and how much? If the Government launches commercial satellites at cost, as NASA has already offered to do, then the taxpayers in general, and not just the users of the satellite service, will be footing the bill.

• **Control of program content**—Controlling the content of radio and television programs transmitted by satellite will create new problems of licensing and regulation. No television system now available can send programs farther than 100 miles or so. Television programs relayed by satellite, however, could be sent from one continent to another. It is easy to foresee that this could become a hot international issue. Just imagine U.S. propaganda programs that could be received by private citizens in Communist countries.

• **Roles and relations of government and private industry**—The American people enjoy a long tradition of leaving telecommunications to private enterprise. Our Constitution guarantees freedom of speech and the press. Yet government support seems inevitable, if only because the necessary technology involves high costs and heavy rocketry. Regulations, in any event, would be essential.

Apart from the central problem of the relationship between government and private enterprise, we will also have to decide what agency within the government will make the policies, lay down the rules, grant licenses, adjudicate controversies and enforce the rules and decisions. Here is an area full of pitfalls and controversies. On what grounds will the responsible agency decide to license one private company rather than another? What agency will be primarily responsible: NASA? FCC?

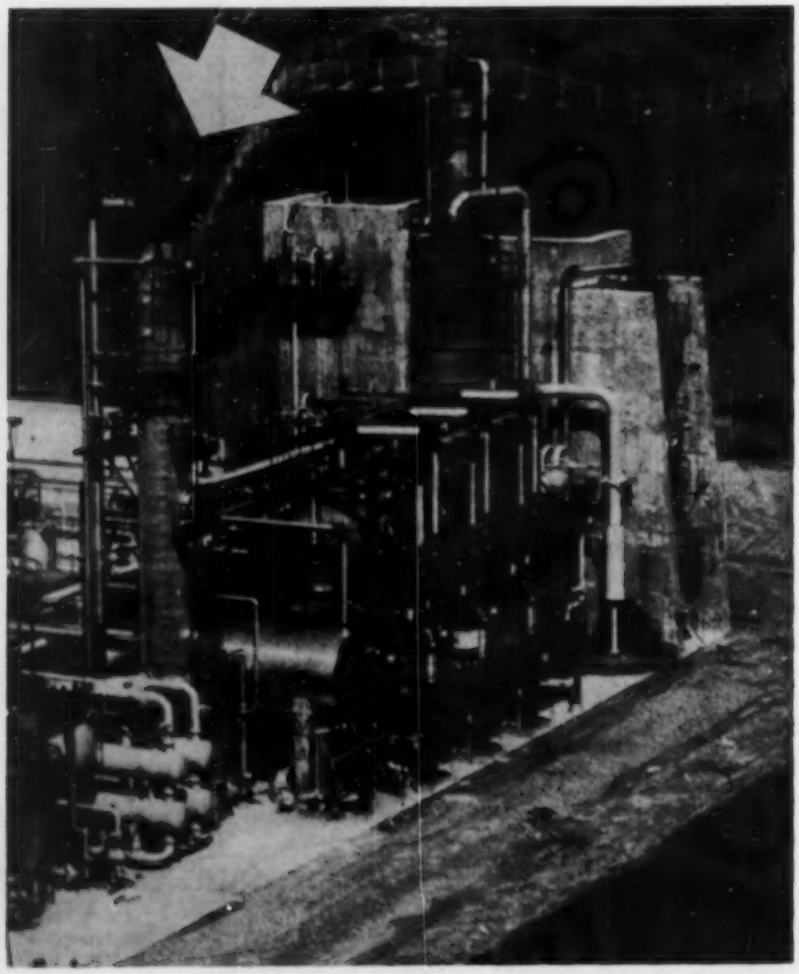
(Continued on page 39)

ANHYDROUS HYDRAZINE in copper mesh bursts into flame when waved in air.

World's biggest . . .

Olin's Anhydrous Hydrazine Plant Producing

Heavily automated facility in Virginia mountains makes fuel for Titan II missile and Dyna-Soar program



AMMONIA CONDENSER section of the plant in Southwest Virginia's Alleghenies.

THE WORLD'S largest anhydrous hydrazine plant went on stream last week at Saltville, Va., with the Air Force as its sole customer.

The anhydrous hydrazine will be used in the *Titan II* missile and in the *Dyna-Soar* program. Built and operated for the Air Force by the Chemicals Division of Olin, the $15-million plant will operate on a round-the-clock schedule.

Precise capacity and certain process details are classified, but the entire three-year contract totals $25 million.

Olin perfected techniques for producing hydrazine shortly after World War II. The first part of the Olin process is the basic Rashig synthesis which leads to the formation of hydrazine hydrate. The next section, dehydration of the azo compound, is regarded by Olin as proprietary.

Basically, hydrazine is the result of three separate reactions. Sodium hydroxide is mixed with chlorine to produce sodium hypochlorite, salt and water. The hypochlorite is then reacted with ammonia to make chloramine and sodium hydroxide. Ammonia is reacted with these two products, forming hydrazine, salt and water.

The plant is highly automated. Four men operate the entire process on a shift. Four other men take care of the loading/unloading, utilities and water processing.

The three shifts with support personnel total about 100 persons.

The plant also has a water pollution control unit that both safeguards local streams and recovers certain chemicals for re-use in the process.

The hydrazine will be mixed with unsymmetrical dimethyl hydrazine in the *Titan II* missile. The mixture can be used with storable oxidizers such as nitrogen tetroxide for propulsion purposes. The two are hypergolic.

Olin broke ground for the plant in June, 1960. Arthur G. McKee & Co., a Cleveland, Ohio, construction firm, finished the job in nine months under the direction of Olin engineers. ⌗

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missiles and rockets

THE MISSILE/SPACE WEEKLY

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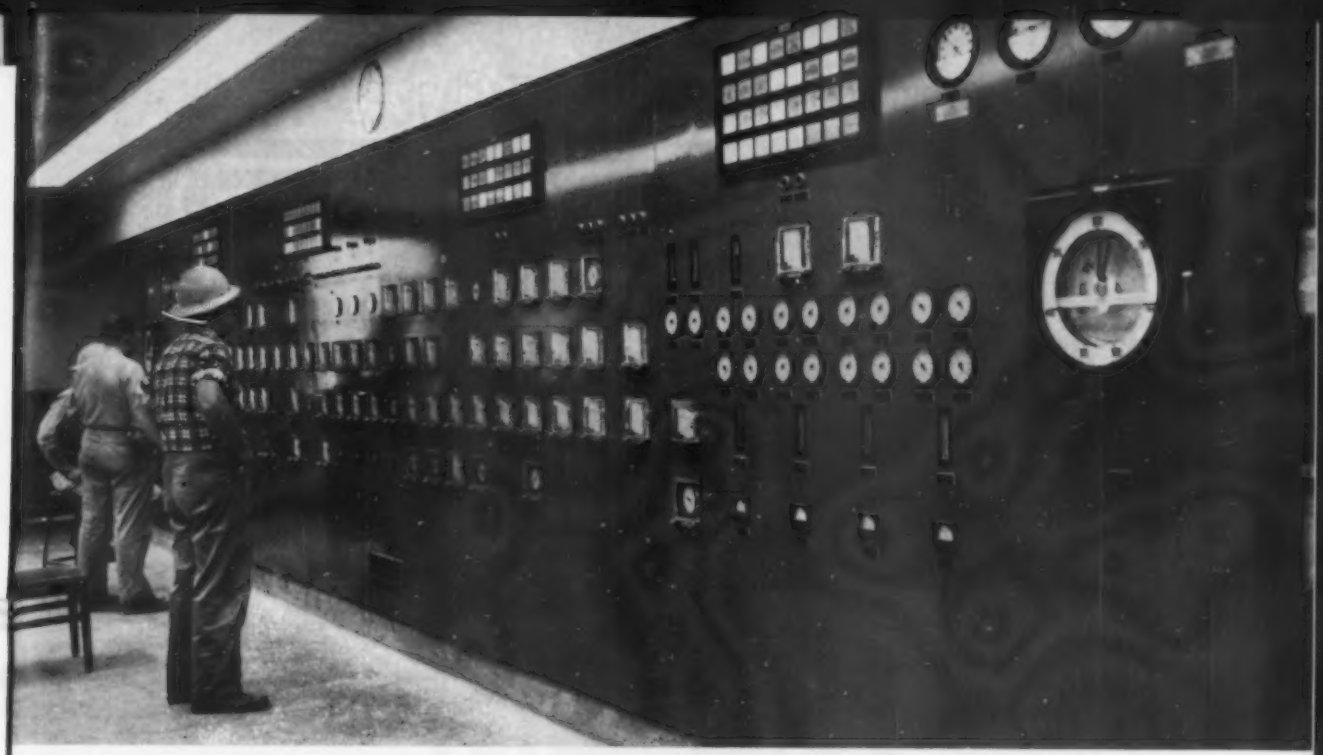

ABOVE: *The nerve center of the highly automated plant. Four men oversee the entire process.*

BELOW: *The distillation tower is an integral part of the proprietary Olin anhydrous hydrazine method.*

TITAN—newest triumph of **S**pace **T**echnology **L**eadership

The nation's first in-silo launch of an ICBM marks a major milestone in the timely development of USAF Titan—and a signal success for an industrial team led by scientists and engineers of Space Technology Laboratories, Inc., under Air Force program management. This successful test confirmed the STL design solution to the unparalleled vibration problems created by the roar of Titan's 300,000-pound thrust booster engine within the confines of its 10-story underground silo. ■ Two years ago, studies by STL as contractor to the Air Force for systems engineering and technical direction of the Titan program, indicated that in-silo launching which provided invulnerability and enormous economy was technically attainable. But one major problem had yet to be solved: proper control of the noise-created vibration during the first few seconds of in-silo firing which, if uncontrolled, would literally shake apart the 97-foot Titan. Research and analysis by STL produced the solution, verified by the dramatically successful test at Vandenberg Air Force Base on May 3, 1961. ■ The successful launch of Titan I demonstrated the soundness of STL silo design concepts for the Air Force Titan II program. Titan II is a fast reacting, highly flexible weapon of maximum range and destructive capability—a new and potent element in deterring aggressor attack. ■ Today STL scientists and engineers are actively engaged in the program that is producing soon-to-be-operational Titan I and quick-reacting Titan II. Their responsibilities in this, as well as in the Atlas and Minuteman programs, create career opportunities for additional numbers of outstanding scientists and engineers. For opportunities with STL in Southern California or at Cape Canaveral, please write to Dr. R. C. Potter, Manager of Professional Placement and Development, at either location.

TITAN TEAM. Program Management: Ballistic Systems Division, Air Force Systems Command. **Major Associate Contractors:** Space Technology Laboratories, Inc., systems engineering and technical direction; The Martin Co., airframe, assembly, and test; Bell Telephone Laboratories and Remington-Rand UNIVAC, radio guidance; AC Spark Plug, all-inertial guidance; Aerojet General, propulsion; Avco Corp. and General Electric, re-entry vehicles; American Machine & Foundry, silo-lift launcher system; A. D. Little, propellant loading system; Daniel, Mann, Johnson, Mendenhall & Assoc. and Ralph M. Parsons Co., architects and engineers; Kellogg Switchboard & Supply Co. and Stromberg-Carlson, communications.

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Technical Countdown

ELECTRONICS

English Build Better Gyro Test Gear

English Electric, developer of Britain's *Thunderbird* and *Blue Water* missiles, uses U.S.-designed gyros—built under Northrop and Honeywell licenses—but has had to develop its own test equipment. Some of the resulting items, they say, are better than any comparable equipment in the free world.

DAC to Aid Nuclear-Age Defense

DOD Damage Assessment Center—scheduled for operational status in July—will include computers and automated display systems to provide instantaneous assessments of damage sustained in nuclear attack. In peacetime, the DAC will be used to provide up-to-the-minute assessments of U.S. and allied military forces and economic resources vs. enemy potential.

ENERGY CONVERSION

Higher Efficiencies

Efficiency of 15-17% has reportedly been obtained with a new vapor thermionic converter developed by General Electric. Power output of 23 watts was obtained at 1530°C. GE says the cesium-vapor converter is a "practical" device and can be reliably produced in quantity for space and military applications.

Municipal MHD Powerplants in the USSR

Plans have been completed by the Russians for MHD powerplants with capacities up to 450,000 kw. Coal, oil, gas and nuclear fuel are mentioned as possible energy sources. Combustion chamber temperatures will reach approximately 5250°F. Efficiency would be 60%. Present knowledge of gases at high temperatures and heat-resistant materials is said to assure attainability of such plants.

ADVANCED MATERIALS

400-lb. Zinc Crystals

A program under way at Semi-Elements, Inc., will increase the size of single crystals of zinc to 400 lbs. The biggest to date is 30 lbs. As is, the price for 5 x 5 in. ingot is $100 per lb.

Hydrogen Embrittlement of Tantalum Prevented

Attachment of an extremely small relative amount of platinum metal to tantalum inhibits hydrogen embrittlement. Scientists at Union Carbide Metals Co. have immersed tantalum samples in HCl at 374°F for more than 1000 hours without embrittlement. The platinum is affixed by sputtering, spot-welding or mechanical attachment. It is not alloyed to the tantalum.

Turbine Diaphragms Investment-Cast

A method for one-piece investment casting of small gas-turbine engine diaphragms has been developed by Austenal Co. The hollow diaphragms are lower in cost, weigh less, and last longer than conventional parts. A wider design latitude and choice of alloys is also possible.

Gas-Lubricated Bearing Operates at 1500°F

Tribo-Netics Laboratories ran a single gas bearing through a temperature range from 75° to 1500°F at speeds up to 65,000 rpm. Under an Air Force contract, the firm is building an all-ceramic rig to raise the operating temperature to 2200°F. Nitrogen, helium, argon and CCl_4 gases will be investigated.

Paging the Fuller Brush Man

Wire brushes will be the main landing gear skids for the *Dyna-Soar*. Since brakes and wheels have been ruled out, the friction generated by the brushes on landing is expected to bring the craft to a halt. Goodyear Tire and Rubber Co. will develop the concept under a $45,000 contract from Boeing Co.

SUPPORT EQUIPMENT

Navy to Get Long-Range Radar

Future Navy missile cruisers and carriers will be equipped with the longest-range height-finding radars yet developed. The AN/SPS-30—proved out in evaluation tests last summer—will be built by General Electric under a $35-million contract. First model is scheduled for delivery in May, 1962.

ASTRONAUTICS

Happy IQSY

Follow-on to the International Geophysical Year will be the IQSY (International Year of the Quiet Sun). Sun spots will be at a minimum during an 18-month period in 1964-65, and scientists all over the world will cooperate then in studying effects of the quiet sun on earth's atmosphere. Some experts predict a crisis in normal radio communications, which depend on an atmosphere strongly ionized by sun activity.

Radiation Shielding in Space Unnecessary?

Martin Co. geophysicists say that heavy shielding will not be necessary to protect space travelers from radiation. Apart from minor spot-shielding, they predict, the vehicle's shell and its equipment will provide adequate protection. The conclusion resulted from work on a feasibility study of the moon-orbiting *Apollo* spacecraft.

ASW ENGINEERING

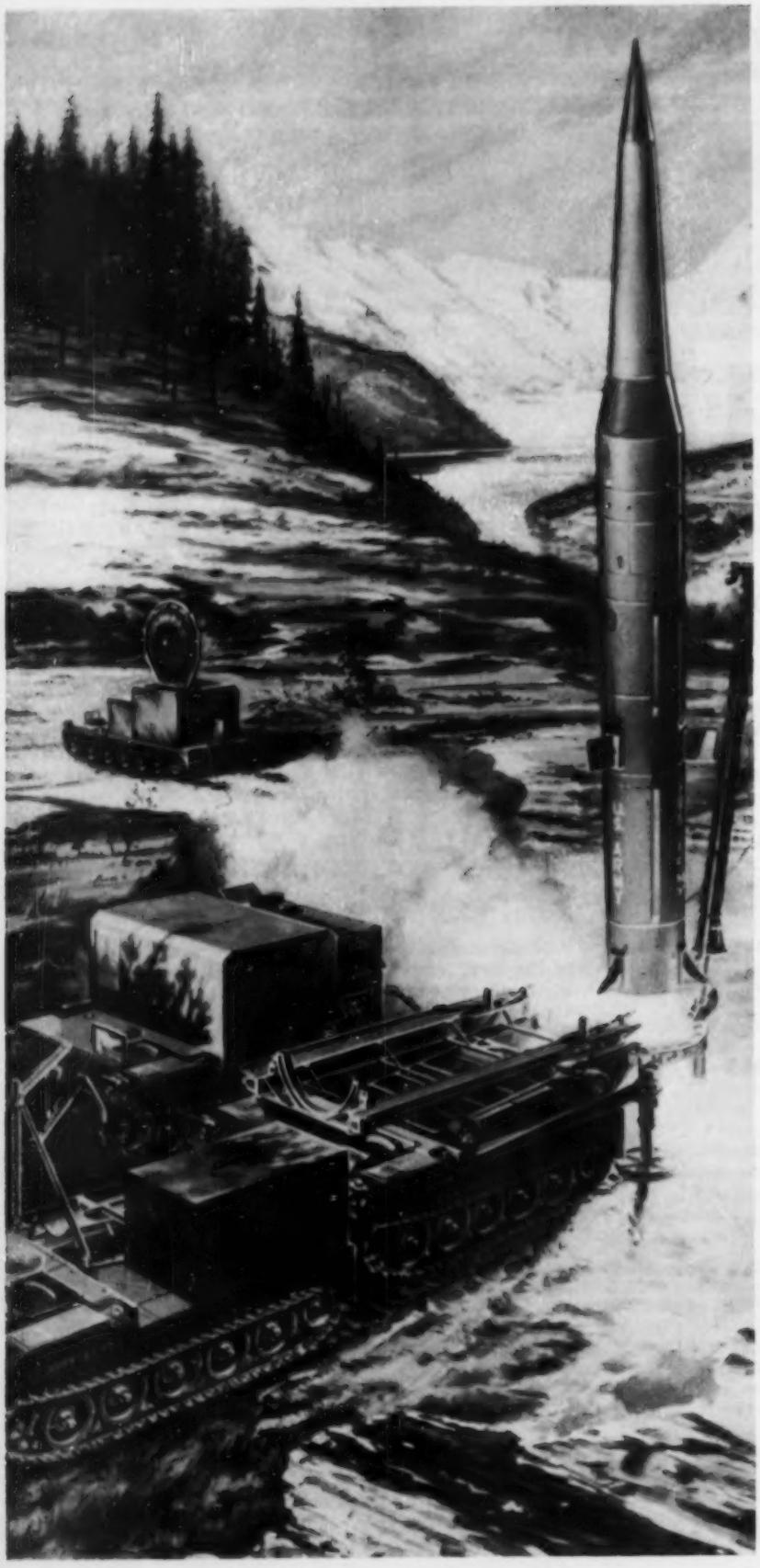
Bat Radar-Sonar Techniques Studied

The Navy is studying bats that catch fish in an effort to develop advanced navigation, communication, and detection systems. Researchers feel that more knowledge of *Noctilio* bats' radar-sonar mechanism, used to locate fish underwater, may yield some interesting techniques that could improve on man-made detection and locating equipment.

An M/R Exclusive . . .

First Details of Pershing GSE

by Hal Gettings



ALL ELEMENTS of Pershing firing section are carried by XM-474 tracked vehicles. Lead vehicle (left foreground) carries warhead, spares and tool chest.

COMMUNICATIONS TERMINAL can be put into service by two men in 10 minutes or less after arrival at firing site.

THE ARMY'S unique approach of developing ground support equipment concurrently with the missile it serves has paid off handsomely in the *Pershing* program. The net result, Army missilemen say, will be a complete fleld-firing section ready to go the day the missile is declared operational.

The lightweight, highly mobile, quick-reacting system is designed for transportability and fast-and-easy interconnection. On arrival at a firing site, its modular units can be tied together, and the missile erected and ready for launch, in less than 10 minutes.

Reliability has been heavily stressed in the missile development—to minimize maintenance, reduce logistic support requirements, and simplify operation with a minimum crew.

The Army has just revealed the components of the complete firing section. This self-sufficient mobile tactical base—transported by helicopter or brought overland under its own power —is composed of four units, each on an identical tracked vehicle.

The missile is carried in its transporter-erector-launcher (TEL) atop one of the XM-474 tracked vehicles. Another vehicle carries the warhead, spares and tool chest. Fire-control, test, and checkout equipment and the primary power supply are carried on a third. The fourth contains the complete communicâtions terminal.

Germans Order Pershings

WEST GERMANY has placed an order for Martin Pershings valued at approximately $120 million.

Sources in Germany indicate that the amount is almost identical to that which the West Germans had earmarked for the purchase of Martin Maces. The Mace order was cancelled earlier this year.

Unit prices of Pershing missiles have not been disclosed. But it is believed the Germans will obtain approximately 60 under their initial order. The 350-mile tactical missile is expected to be operational late this year.

• **TEL**—Principal item of support equipment of the *Pershing* firing section is the TEL. This unique wheeled vehicle carries, erects, and serves as a launching platform for the missile. It rides on an XM-474 or can be towed on its own wheels; it can launch the missile in either position.

An umbilical mast is an integral part of the system.

Power for operation is supplied by two motors. An 11-hp motor raises the missile to within five degrees of vertical. A 3-hp motor stabilizes the erector at 90 degrees from the horizontal. Erector boom, with missile, can be raised or lowered in one minute. Stabilizer jacks and azimuth ring are integral components of launch platform.

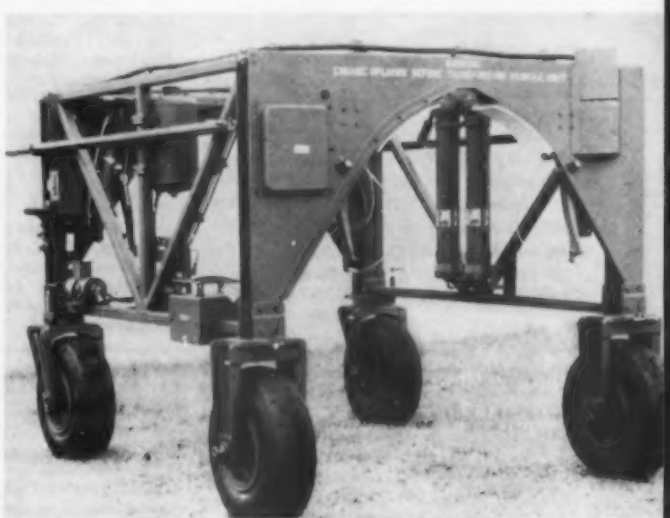
Three integral stabilizer jacks are lowered to provide the stable base for firing. The two forward jacks are lowered electrically and the rear jack manually. Base plates are installed on the stabilizer jacks to give added stability and flotation.

After the stabilizer jacks are lowered to the base plates, the launcher is then automatically leveled. An electrical interlock prevents missile erection until leveling is accomplished.

During erection, the missile is physically supported at its base by a peripheral clamp, and at the forward end by a clamping device attached to the boom.

The missile is raised to within five degrees of the vertical by the erector boom. The remaining five degrees of erection is accomplished by a smaller motor, automatically initiated, which lowers *Pershing* slowly to the launcher. This fine control, with the smaller motor, is necessary to prevent missile

COMMUNICATIONS HUT can be mounted on XM-474, carried by helicopter, or towed (on "mobilizer" wheels) by light truck. It is lifted by jacks to allow vehicles to back underneath.



DOLLIES EQUIPPED with built-in hydraulic lifts are used to pick up and carry Pershing sections for air transport and re-supply handling.

CHINOOK YHC-1B HELICOPTERS can carry entire Pershing firing section, giving the Army's new tactical missile system its high degree of mobility.

XM-474 Tracked Vehicle

Length (overall):	18 ft.
Width (overall):	8 ft. 4 in.
Reducible height:	5 ft.
Ground clearance:	16 in.
Performance:	
Speed forward	40 mph
Cruising range:	200 miles (approx.)
Max. grade (ascending, descending):	60% slope
Max. side slope:	30% slope
Curb weight (with fuel):	11,900 lbs. (approx.)
Payload capacity:	12,100 lbs. (normal) 16,300 lbs. (overload)

Power train and suspension components are identical with those in standardized M-113 personnel carrier.

XM-474 can ford 42 inches of water and, with adaption kit, can be made amphibious. Vehicle weight is carried by 10 dual road wheels rolling on tracks. Wheels are mounted, five on each side, on road wheel arms, splined to torsion bars. Vehicle is capable of operating, under full load conditions, in climate ranging from −65°F to +125°F.

Pershing's Vital Statistics

Length: 34 feet
Diameter: 40 inches
Propulsion: Two-stage, solid-propellant rocket motors
Guidance: Inertial
Warhead: Nuclear
Range: Classified (Exceeds *Redstone* range of 200 miles)
Weight: Classified
Payload: Classified
Contractors: Martin-Orlando, prime; Thiokol Chemical, rocket motors; Tapco Group of TRW, TEL; Collins Radio, communications; Bendix, guidance; Bulova Research, fuzing and arming and adaption kits; Ford Instrument, fuzing and arming (parallel development)

YHC-1B Chinook Helicopter

Dimensions: Cargo compartment, 6' 6" high; 8' 3" wide; 30' 2" long. Rear entry access, 7' 6" wide. Loading ramp, 6 degrees, 40 minutes slope.
Payload: Normal mission payload for 100 n.m. radius, over three tons. Alternate mission payload for 100 n.m. radius, six and one-half tons.
Cruise speed: Average 125 knots at 5000 ft.
Service ceiling (one engine out): 7000 ft.

oscillation when it reaches the vertical position.

When the missile is in the vertical position, the boom is returned to the travel position. The missile can then be automatically rotated to the firing azimuth.

• **Communications terminal**—Complete battlefield communications facilities for the firing section are contained in one pack which provides both radio and teletype equipment for local and higher echelon contact. This portable communication terminal—the AN/TRC-80—can be on the air in 10 minutes after arrival at a site. Using tropospheric scatter, operation of the terminal is unaffected by ionospheric conditions or conventional ionospheric jamming techniques. The system provides 777 operating channels without crystal changing.

• **Power pack**—Primary power for the firing section of the *Pershing* battalion is provided by a compact, portable unit mounted on an XM-474. A gas turbine engine powers an ac-dc generator which supplies electric power to operate the TEL, fire-control equipment, and the missile. The turbine engine also supplies compressed air to separate the umbilical mast from the missile and to other areas as required.

Pershing is the first ballistic missile development program conducted by a prime contractor for the Army. It also is the first which called for concurrent development of the ground support equipment with the missile. The success of this approach has been borne out by the fact that all test firings have been made from the TEL. Other support components have come along on the same schedule to reach a common operational date.

The entire *Pershing* development program has met with unusual success. Prime contract was awarded Martin-Orlando in March, 1958. One year later the first missile was delivered to ABMA for static test and captive firing. The first flight test came in February, 1960—less than two years after contract award.

The sixth launching was made from the TEL, mounted for the first time on its tracked-vehicle carrier. This, too, proved successful.

An essentially operational version of the *Pershing*—with improved motors, new configuration, and internal design improvements—was successfully fired on April 21, 1961.

In all, a total of 15 missiles have been fired in the R&D series, Thirteen of these were unqualified successes, one a "partial" success, and only one a total failure. From this, Army missilemen are confident that the missile will become operational on schedule late this year. ¤

U.S. Urged to Exploit Nuclear Lead

by John F. Judge

GATLINBURG, TENN.—U.S. space programs should be directed towards the planets—with lunar missions a preliminary or interim operation using the technology developed for planetary shots.

H. B. Finger, Manager of the Joint Atomic Energy Commission-National Aeronautics and Space Administration Space Nuclear Propulsion Office, said that such a long-term program would depend heavily on nuclear rockets—a field in which the Russians are a sorry second.

Finger told a Space Nuclear meeting that three research reactors have been tested with gaseous hydrogen as a propellant and water as the pressure shell and nozzle coolant. The *Kiwi-A* series was successful and the *Kiwi-B* series of reactor tests, to be initiated later this year, will include some runs with liquid hydrogen as a propellant and as a coolant for all critical parts.

The *Kiwi-B* series should lead to development of reactors for the first flight tests of the nuclear rocket system.

Finger cautioned that success in the nuclear rocket program is not yet assured, but he said the work to date is very encouraging.

The meeting was sponsored jointly by the American Rocket Society and the Oak Ridge National Laboratory, operated for the AEC by Union Carbide Corp.

A special session was devoted to the *Saturn* booster system. Dr. Wernher von Braun described the *Saturn* in detail and covered the *Apollo* concept. The rocket expert said that a set of fins would be added to the big booster for better control under adverse wind conditions.

Von Braun's description of the *Apollo* vehicle did not include any glide capability. The *Apollo* would re-enter in a manner similary to the *Mercury* capsule.

Space rendezvous, escape procedures and power module configurations were also mentioned in connection with *Apollo*.

Von Braun said nuclear rockets would probably be limited to orbit operation and beyond—no ground launchings. He also sounded a wary note by categorizing nuclear propulsion as a "day-after-tomorrow" event. But in any case, he said, the work must be started today.

Flight Test Schedule

CY	1962	1963	1964	1965
Arc Jet Engines	1	3	2	1
Ion Engines	3	10	7	2
MFM Engines	—	1	3	3
SCOUTS	2	7	6	3
Arc Jet Engines		1	1	—
Ion Engines		1	2	1
MFM Engines		—	1	1
AGENAS OR CENTAURS		1	2	1
Arc Jet Engines				1
Ion Engines				1
MFM Engines				—
CENTAURS				1

TENTATIVE NASA flight plans.

• **Big science**—The triple "diseases" of large-scale science—journalitis, moneyitis and administratitis—were covered in detail by Dr. A. M. Weinberg, Director, ORNL.

The nuclear expert expressed fears that big science is ruining the universities by turning qualified professors into publicists, administrators and spenders of big money—at the expense of their professorial duties.

Observing that big science is, with all its faults, here to stay, Weinberg offered a number of suggestions based on his experience with a national laboratory.

He proposed that technical universities be created close to, or in conjunction with the large government laboratories. The main advantage would be the fact that the national laboratories have already made their peace with big science—the onerous housekeeping function, the inevitable layer of administrators and publicists are already in being.

AEC security took its usual toll of papers at the meeting, and in many cases the non-classified presentations had to be restricted to generalities. But rocketmen were given a fairly complete picture of the problems and areas of emphasis in nuclear applications to propulsion and power.

The nuclear experts in turn were were given an insight into electrical propulsion and its demands on nuclear technology.

• **Kilowatt propulsion**—NASA's electric propulsion development program, including tentative flight plans, was discussed by Ernst Stuhlinger, Director, Research Projects Div., Marshall Space Flight Center.

The NASA expert outlined the five-phase development program each of the three systems of propulsion will undergo. Arc jet, ion and magneto-fluid-mechanic (MFM) engines will all flow through component research and development, laboratory model, flight testing and mission phases.

The arc jet is farthest along the road. A 1-kw flight model slated for a short-time flight test in late 1961 is being designed by Plasmadyne Corp. If successful, this model may result in an early application of arc-heated systems for position and attitude control of satellites.

Larger engines for a power output of 30 kw are under development at GE and Avco. These may lead to a flight model, to be flight-tested together with a *SNAP-8* power supply on a 1965 satellite.

Short-flight ion engines are being developed by NASA at the Lewis Research Center, Hughes Aircraft and Electro-Optical Systems.

Stuhlinger said that 15 to 20 *Scouts*, carrying 20 to 25 ion engine models and some arc jet and MFM engines, will be launched between 1962 and 1965. The *Scout* vehicle will provide a total test time of 1-2 hours during a steep parabolic flight.

Two engine models will be carried on each *Scout*, mounted on outrigger arms so that their thrust will increase or decrease the spin of the payload capsule.

To cut costs and increase reliability, the engine-bearing capsules, power supplies, programer, telemeter and command receiver will be of standard design.

J. W. Stearns of Jet Propulsion Laboratory analyzed the various space missions involving electric propulsion. Classes included a planetary flyby, a planetary capture and a planetary orbiter. In each case, the electrical propulsion system is assumed to be in a 300-mile earth orbit.

Missions studied and discussed by Stearns were Mars and Venus orbital shots, Jupiter spacecraft and an out-of-the-elliptic probe.

• **Plasma core reactors**—Advanced concepts for high-acceleration propulsion systems are few in comparison to the innumerable low-acceleration sys-

Limitations Upon Principal System Variables

	Lower Limit	Upper Limit
Size	1. Criticality	1. Wt. of moderator-reflector 2. Excessive fuel inventory 3. Excessive mag. field volume 4. Fabrication difficulties
Temperature	1. Fuel ionization temp.	1. Radiative heat transfer to walls 2. Propellant ionization
Magnetic Field Strength	1. Plasma confinement 2. Cost of max. tolerable fuel loss by diffusion	1. Electric power requirements 2. Coil weight
Electric Field Strength (Homopolar Configuration)	1. Plasma rotates too slowly a. Therefore unstable b. Therefore axial diffusion intolerable	1. Supersonic flow problems 2. Excessive voltage drop across plasma
Propellant Flow Rate	1. Flow channel cross section excessive (Therefore moderator too heavy)	1. Excessive pressure 2. Helmholtz waves (Therefore propellant swept through nozzle)
Plasma Rotational Velocity (Homopolar Configuration)	1. Plasma instability (Therefore max. permissible propellant flow rate too slow) 2. Approaches diffusion properties of simple magnetic bottle	1. Shock waves and boundary layer turbulence 2. Rotational kinetic energy wasted in spinning propellant

SOME OF THE PROBLEMS involved in developing plasma-core reactors.

tems being investigated. S. T. Nelson of the Aerospace Corp. says this is understandable when it is realized that, for all high-acceleration systems, the specific impulse is proportional to the square root of the engine operating temperature (T) divided by the exhaust gas molecular weight (M).

If the exhaust material is dissociated hydrogen, M would be essentially minimized. Performance would have to be improved by raising the temeperature. Nelson pointed out that the maximum steady-state temperatures withstood by the most refractory structural materials correspond to I_{sp} values in the neighborhood of 1000 sec.

Two approaches have been proposed to overcome this limitation—Project *Orion*, which limits the interaction in time by short-duration pulses, and the plasma-core reactor, which limits the interaction in space by eliminating all solid structure from the immediate vicinity of the hot gas and replacing the confining walls with electromagnetic fields.

Nelson, in one of the longest papers delivered at the meeting, described the plasma-core reactor in a propulsion system capable of imparting a vehicle acceleration greater than 1 g.

In its simplets form, the plasma-core reactor consists of a plasma of fissionable material, confined within a cylindrical or ellipsoidal zone about the axis of a cylindrical chamber by means of a longitudinal magnetic field. This field is generated by electrically conducting coils, bearing strong currents, which surround the chamber.

The field is uniform except for the ends of the cylinder, where it is more intense due to a higher concentration of coils. The resultant arrangement of parallel lines of force bunched in at the ends is referred to as a magnetic bottle; each end is called a magnetic mirror.

• **Nuclear hot dog**—Surrounding the glob of fissionable material in the simplest device is a layer of hydrogen propellant, forming an annulus coaxial with the plasma but inside the solid, porous, chamber wall. The hydrogen flows axially down the chamber, absorbing enthalpy from the plasma core. It is finally exhausted through a suitable nozzle after being heated to dissociation but not ionization.

Nelson says the reason hydrogen is not ionized is that it must be expelled while the expensive fissionable material is retained. The plasma-core reactor relies on magnetic confinement of an ionized fissionable gas which "sees" the confining field barrier and upon the escape of non-ionized hydrogen which does not.

From a strictly nuclear point of view, says Nelson, it is feasible to construct a critical plasma core of reasonable dimensions and fuel inventory. But it is found that the core must be greatly enlarged beyond its theoretical minimum size for non-nuclear reasons.

In addition to enlarging core dimensions to minimize plasma diffusion processes, it is also necessary to maximize the optical depth of the hydrogen layer. Since the initial constraint upon the system variables requires a high-acceleration vehicle, thrust levels upwards of 10^7 lb. are implied. This means propellant flow rates at least of the order of several tons per second.

To pump hydrogen longitudinally across the core at such rates without resorting to excessive axial velocities, the cross-sectional area of the hydrogen annulus coaxial with the plasma must be rather large.

Nelson covered many of the problems relating to the plasma-core reactor. One of the most formidable—plasma instability—was not treated, but the Aerospace Corp. expert suggested some future work in the area. Perhaps the greatest source of instability in the simple magnetic bottle will prove to be Helmholtz waves generated at the plasma-propellant interface.

Other instabilities such as those of the flute, kink and sausage types must also be investigated, says Nelson. Furthermore, it is necessary to develop an analysis of the assorted types of oscillations to which plasma cores of several configurations would be susceptible, and methods of damping.

One last problem area Nelson describes as the most crucial. The central question is: Given a hot, ionized gas—which is itself a heat source—and given a region of non-ionized gas whose function is to absorb radiant energy, and which is situated between the hot source and a physical wall enclosing the entire cavity, what is the temperature profile throughout the absorber as a function of its thickness?

This problem is compounded by our ignorance of the absorptivities and emissivities of hydrogen, and particularly of uranium, at the temperatures and pressures of interest.

• **Doped hydrogen**—Another complicating factor is the radial distribution function for plasma particles in configuration space. In practice, fuel ions will be distributed in the steady state throughout the hydrogen, falling off from maximum density at the interface to some minimum value at the wall.

These fuel ions, while an economic loss, also constitute a doping of the relatively transparent hydrogen by particles more opaque to the incident radiation. This relieves the wall-cooling problem enormously.

Nelson says there is a possibility of further doping the hydrogen with a good radiation absorber having suitable nuclear properties. All of this introduces the hope of maintaining the wall temperature within manageable bounds—but vastly complicates the heat-transfer analysis. ⌗

Exhaustive Tests Bring Reliability

THE XM-55 engine for the first stage of *Minuteman* is a veteran of 61,515 major component tests.

The figure is likely to increase by a factor of two or more by the time the qualification test program is completed.

Dr. Harold W. Ritchey, vice president of Thiokol Chemical Corp., says the tests illustrate the means necessary to attain acceptable reliability in a sophisticated solid-propulsion system closely approaching the boundaries of design knowledge.

• **Balancing act**—Ritchey says an intelligent program design based on an extensive testing program can obtain more reliability per dollar. But reliability must also be balanced with entire program cost, schedule and performance.

The solid-rocket expert compared the testing programs of the XM-20 solid engine used in the *X-17* re-entry test vehicle, the XM-55 *Minuteman* engine, the *Atlas* LR-89 engine and the *X-15's* XLR-99 man-rated engine.

The XM-20 attained a high degree of reliability rapidly and at a relatively low cost because the state of the art was not close to design knowledge boundary.

The *Atlas* LR-89 reflects the larger number of critical components required in a liquid engine as compared to a solid. But reliability is attainable by the experience gained during an extensive test program.

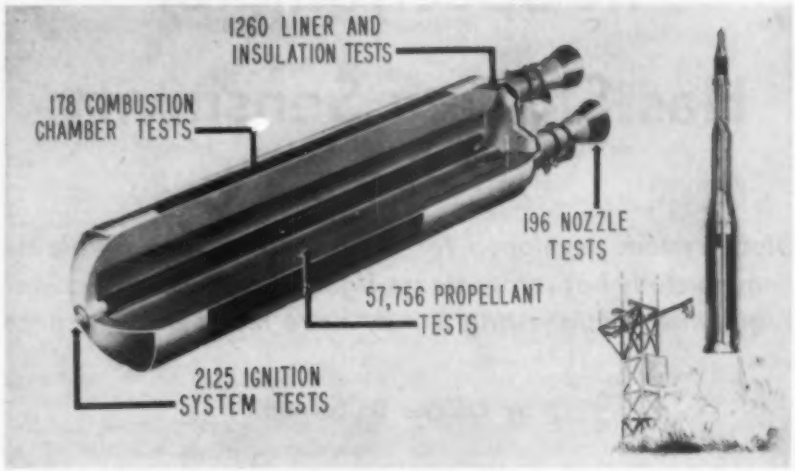
Ritchey emphasized that the complexity associated with more components does not necessarily cause lower reliability—it merely generates a need for extensive test experience.

The statistical reliability represents the combined test experience for both the MA-2 and MA-3 designs. Modifications incorporated into the MA-3 through design and reduction of components have substantially improved reliability compared to MA-2 design.

Based on 28 failure-free tests, a current statistical reliability of 92.8% has been achieved in the LR-89.

A field reliability of 97% has been attained with the XLR-99 even though it has more components than the LR-89. The higher reliability figure was generated by the man-rated safety requirements.

Ritchey pointed out that the final result of reliability attained through comprehensive testing is dependent to a considerable extent on the ability of manufacturing personnel.



NON-DESTRUCTIVE TESTS in first-stage Minuteman engine numbered 144 hydrostatic checks in combustion chamber series. All other tests were destructive.

• **Program aim**—The entire development effort in a propulsion system might be regarded as a program of design and testing to achieve the required reliability. Thus the flight testing would be only 10% of the costs, with engine static tests taking 55%, component tests 30% and initial design 5%.

Within this there is an additional effort devoted to an analysis of the test results. This means highly trained people and complex computing machinery.

Ritchey notes that flight tests are frequently conducted to acquire data on the entire system. If this is obtained, a test can be a success even though military goals are not all achieved.

In addition, on-board instrumentation and ground support equipment required in many flight tests are, in themselves, much more complicated and unreliable than the counterparts demanded in a military operational missile.

Since the useful life of this type of test equipment is relatively short, it is often more economical to accept a relatively low reliability in the equipment. Thus a nominal risk of flight failure can be assumed to be more advantageous for the overall program. ⌗

	XM-20 (X-17-RTV)	XM-55 MM-WING I	LR-89 ATLAS
1. NUMBER OF COMPONENTS	6	9	33
2. NUMBER OF COMPLETE ENGINE DEVELOPMENT TESTS	6	132*	3177
A) ENGINEERING DEVELOPMENT AND STORAGE TESTS	1	82*	
B) PREFLIGHT RATING TESTS	5	12	3126
C) QUALIFICATION TESTS	0	18*	
D) DEVELOPMENT FLIGHT TESTS	0	20*	51
3. ACCUMULATED RUNNING TIME TO DATE	1220 SEC	2350 SEC	155,750 SEC
4. TOTAL FLIGHT TESTS TO DATE	39	1	74
5. FLIGHT FAILURES DUE TO FIRST-STAGE PROPULSION	0	0	4
6. RELIABILITY DEMONSTRATED (90% STATISTICAL CONFIDENCE) PROJECTED AND CURRENT	95.7	98.3* 90.5	91.4

* PROJECTED TO COMPLETION OF WING I

TYPICAL TEST AND RELIABILITY records illustrate that the nature of the reliability achievement problem is closely related to system complexity and design knowledge in relation to the state of the art.

IR Spectrometer Has Striking Sensitivity

Block system developed for Air Force and now available commercially has compactness, light weight and low-power requirements suggesting it may have many uses in space

by Charles D. LaFond

HAND-HELD Interferometer Spectrometer developed by Block Associates, Inc. has been used by Air Force for missile plume studies at Cape Canaveral. The unit has gain of over 1000 in sensitivity, developers say, compared with conventional IR spectrometers.

A GAIN of more than 1000 in sensitivity over conventional infrared spectrometers has been achieved by a conceptually new infrared spectrometer developed by Block Associates, Inc. of Cambridge, Mass.

The system is compact, lightweight and low-powered. Its portability and unusually high gain suggest a variety of potential uses: celestial research, meteorological studies and geodetic research from the ground or in flight, plasma research, and remote high-accuracy temperature measurement. Many of these applications already are being planned by the Air Force.

One of the first to use the hand-held version of the spectrometer was the Geophysics Research Directorate (GRD) of Air Force Cambridge Research Laboratories. Engineers there employed the system successfully to measure and analyze infrared radiation from missile plumes at Cape Canaveral.

A gunstock-mounted model of the instrument continued to obtain spectral data even after much larger conventional spectrometers lost the missile, Block said.

A two-package commercial version of the spectrometer is now commercially available, the company said. It consists of an optical head and separate electronics with a selection of IR detectors. Cost, said Block, is about $4500 for a complete instrument.

• **New analytic tool**—Infrared spectroscopy has developed into one of the most powerful analytical tools. In the present state of the art, however, its use has often been limited by inadequate sensitivity.

To overcome this as well as other limitations, and thereby extend the application of IR spectroscopy, Block, under partial sponsorship of GRD, developed the techniques of interference spectroscopy, then reduced them to practical laboratory and field instruments.

The interferometer spectrometer evolved from this development work achieves its very high sensitivity in part by making more efficient use of the measuring time. All wavelengths are examined simultaneously, instead of singly as in a conventional spectrometer, the company said. Also, the device does not require the narrow entrance slit usually employed, and this enables it to accept more radiant energy from the source.

• **Advantages numerous**—The advantages of this instrument as compared with standard dispersive spectrometers (prism and grating types) of equivalent resolution (40 cm^{-1}; i.e., 0.004 microns at 1 micron) include:

1. 1000 to 10,000 times more sensitivity when examining extended sources.
2. Light weight, small size, and low power consumption.

3. Rapid scan: 4 spectra/second can be accomplished with the present instrument. (Even if this scan rate is not fast enough for a particular very rapidly fluctuating source, Block asserts, the interferometer still shows the correct relative shape of the spectral distribution. The only loss is in resolution.)

4. Capability of using two different detectors to simultaneously cover a very broad spectral region in one output channel. This is equivalent to having a single detector which has the composite characteristics of the two detectors.

5. No problems with any overlap of wavelengths or spectral orders; broad spectral regions can be handled conveniently.

The system apparently offers a great deal of flexibility. It can be used with a variety of fore-optics systems to provide any desired field of view, a company engineer said. Also, when a point source is being examined, exact aiming of the system is unnecessary, since there is a large entrance aperture into the spectrometer.

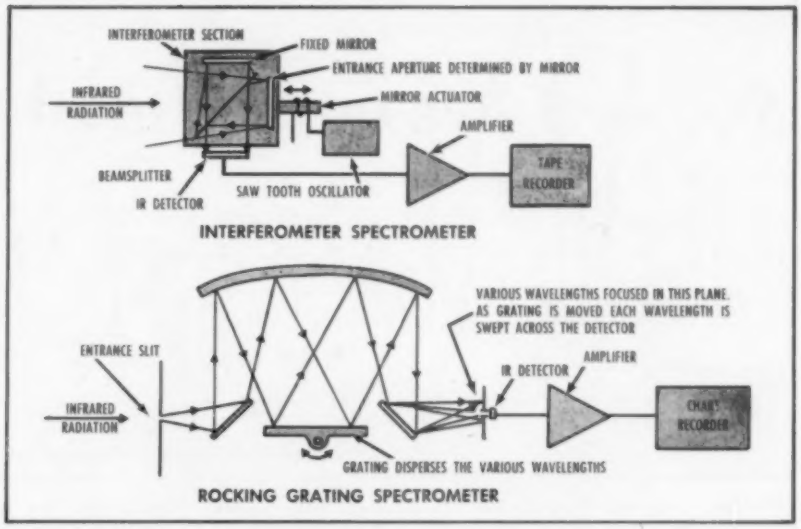
The spectrometer, he said, can be used with detector arrays to examine many parts of the total field of view simultaneously. Finally, it can be used with reticles for space filtering to permit separating point sources from the background.

• **Principle of operation**—A Block official recently outlined the operating principle of the new spectrometer with an acoustical analogy. If one has a sound to be analyzed, he said, it is first picked up by a microphone and then the output from the amplifier is recorded on tape. The tape can be played through a wave analyzer to show the amplitude of each frequency component in the sound.

This same procedure could be used to analyze infrared or other electromagnetic radiation—if detectors were available that were fast enough to follow the fluctuations of the electromagnetic waves. However, an interferometer can be employed to slow down the waves.

The process, he said, is analogous to obtaining slow motion in a movie projector. The interferometer can be considered as making a picture of the wave trains of light. This picture is the fringe pattern produced by the interferometer. When one of the mirrors in the interferometer is moved back and forth at a slow, constant velocity, the "camera" becomes a movie projector; the "picture" moves. The motion is manifested as an alternate brightening and darkening of the central fringe.

An IR detector placed at the central fringe converts these cyclic changes into an alternating electrical signal. If the mirror velocity is kept constant at a predetermined value, said the Block spokesman, the frequency of the a-c signal out of the detector is directly related to the wavelength of incident radiation, assuming for the moment that the incident radiation is at one given wavelength (monochromatic).



COMPARISON of Interferometer and Rocking-Grating Spectrometers.

If another wavelength twice as long as the first (hence half the frequency) should be substituted as the incident radiation source, the a-c output signal from the detector would be at one-half the frequency of the first. The amplitudes of the two signals would remain the same if the maximum brightness of the two sources were the same.

If incident radiation containing many wavelengths were introduced into the system, the output of the detector would consist of a superposition of all the a-c signals which correspond to all the wavelengths in the source.

This superposition of many a-c signals is the same thing that happens in a microphone when the incident sound consists of many notes.

The electrical outputs of the microphone system and the interferometer-detector system are equivalent. Consequently, the same procedure of using tape recording and playing it back through an audio wave analyzer permits the infrared spectrum to be recovered just as the acoustic spectrum is recovered.

Mathematically, it can be considered that the interferometer takes the Fourier transform of the incident radiation, and the wave analyzer takes the inverse transform.

• **Data reduction**—The use of a tape recorder and wave analyzer combination is the simplest way to convert the superposed frequencies (called an interferogram) back into the original spectrum.

The paper-feed of a chart recorder is mechanically linked to the frequency tuning control of the wave analyzer; as the paper slowly advances, the frequency is changed. This produces a spectrum which has as its abscissa a scale that is linear with frequency (or wavenumber).

Data reduction is not limited to use of the above procedure. If it is desired, the interferogram can be converted into digits and the inverse transform calculated on a computer.

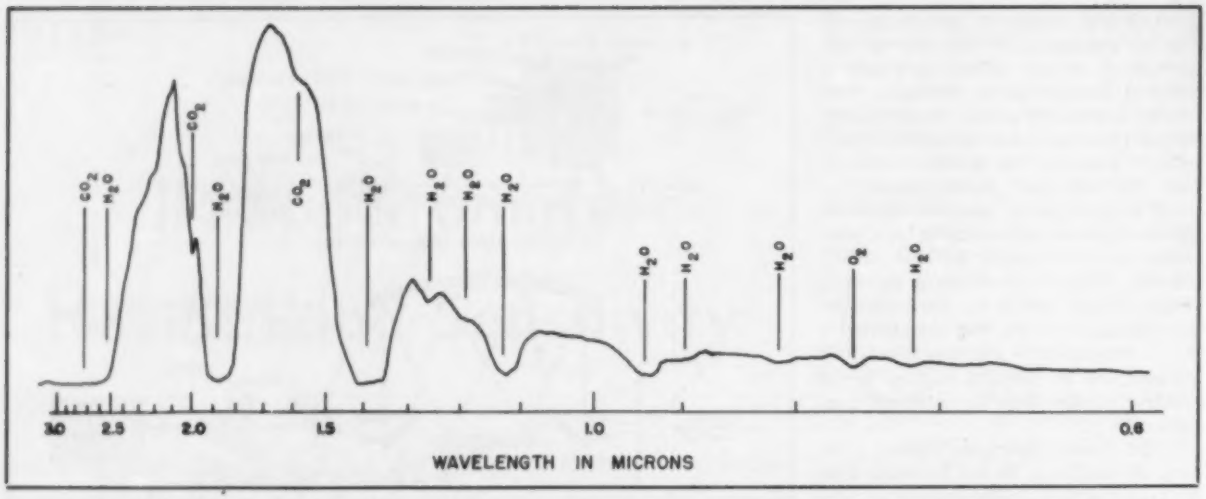
The fact that each wavelength of the source appears as a different electrical frequency permits the use of several additional methods of data display. If a spectrum is desired without going through the delay of tape recording and wave analysis or computer programing, this can be accomplished by feeding the output of the spectrometer directly into a panoramic wave analyzer.

If the interest is only in a few wavelengths, several tunable narrow bandpass filters can be placed in the output. These would continuously indicate the energy level of each of these wavelengths.

• **High gain vs. time**—The most striking advantage of interference spectroscopy over conventional techniques is the large gain in sensitivity. This comes about from two factors, according to Block:

—The interferometer has a much larger entrance aperture. It is determined by the mirror size, whereas conventional instruments are limited by slits. Essentially, the product (entrance angle x area), which might be called "throughput," is much higher in an interferometer. For typical instruments, this can be a factor of 100 greater than in a conventional spectrometer.

—The interferometer spectrometer examines each wavelength throughout the entire time period of each scan. In a conventional instrument, each wavelength is examined for only a very short



SPECTRUM OF MOON obtained by interferometer spectrometer under the following conditions: PbS detector; 8-cm aperture, glass optics; 1.5° field of view; 6 seconds recording time at 3 scans per second; approx. 54 cm^{-1} resolving power.

part of the scan time (1/n th the scan time if n is the number of resolution elements). A basic theorem of information theory shows that signal-to-noise increases as the square root of the measuring time; hence, an interferometer achieves a gain which is n½ for the same scan time. For typical instruments this can be a factor of 50. Furthermore, this gain is realized even when examining point sources where the throughput gain is not large.

The price for these gains is dependent on the data reduction method. If the tape loop and wave analyzer are used, it is necessary to wait until the wave analyzer has been tuned through the entire range of frequencies which correspond to the spectral region of interest. Here, gain is paid for with a time delay in the order of 15 minutes for data reduction—that is, plotting the spectrum.

If a panoramic wave analyzer is used, the presentation is immediate, but the resolution may be limited.

• **Broad usage planned**—Several applications for the Block instrument are currently being implemented or are in the planning stage by GRD in Cambridge.

Balloon- and aircraft-borne instruments will be used for measurements of infrared energy radiated by the earth. Because of the sensitivity of the instrument, these measurements can be accomplished conveniently, using the lower-sensitivity long-wavelength detectors such as thermistor bolometers.

The spectral region from 4 to 40 microns will be of primary interest in this program. This will provide information concerning the outward-radiated portion of the heat balance of the earth. Data obtained will help to improve the understanding of the atmosphere and thereby to improve long-range meteorological predictions. Also, this measurement will provide general information on the earth as an infrared background. This is of special importance in the design of various types of military surveillance systems.

Other measurements by these balloon-borne instruments are planned to determine the variation of width and attenuation of certain spectral absorption lines characteristic of the water and carbon dioxide in the atmosphere. Since these characteristics vary with temperature, this provides a method for obtaining a temperature profile of the atmosphere as a function of altitude.

The small size, light weight, and low power consumption of the instrument, Block believes, make it possible to go to altitudes of 120,000 ft. with standard balloons—instead of the usual 90,000-ft. limit imposed by the weight of heavier conventional instruments.

A study of the infrared transmission of the atmosphere at night is another program. Most of the existing atmospheric transmission data are obtained by pointing a spectrometer at the sun and measuring the spectral absorption due to the atmosphere.

However, the properties of the atmosphere change with temperature; hence it is desirable to determine these at night by using the moon as the source. This is difficult with conventional spectrometers because of the low intensities of the radiation reflected from the moon.

The study of radiation from aurora is another example of work with weak sources. This information is needed to aid our understanding of these phenomena. It is of major significance in radio communication on the earth as well as from the earth to space vehicles.

Analyzing the radiation from various stars, planets, and nebulae is still another field for exploiting the instrument's high sensitivity coupled with its large pointing tolerance, which overcomes the problem of atmospheric scintillation. This scintillation causes a point source to move about in the focal plane of a telescope—thus making it very difficult to image it onto the narrow slit of a conventional type of spectrometer.

In addition to these applications, a number of other measurement projects utilizing the Block Associates' interferometer spectrometer are being considered by GRD. These programs, which will increase overall knowledge of the atmosphere and the solar-terrestrial relationship, include: measurement of solar flux and high-energy particles, study of scattered solar radiation in the upper atmosphere, investigation of the composition of the atmosphere, and study of night air glow.

In many of these programs, it is possible to make measurements from various locations (using anything from ground-mounted telescopes to balloon-borne platforms) with the same instrument. This will make the correlation and comparison of data relatively simple and quite reliable, Block said. ⠿

F-1 to Get LOX from Big Air Force Plant at Edwards

A 2000-TON LOX storage plant is nearing completion at Edwards AFB, Calif., for the *F-1* engine test program.

The plant, about a half-mile from the F-1 test stand, is being built for the National Aeronautics and Space Administration. NASA will obtain LOX for the plant from the Air Force when the facility goes into operation this summer.

The LOX will be carried to the test stand in a vacuum-jacketed pipeline. The facility is a half-mile from the stand for safety. ⠿

Space Power from Microwave Energy?

Feasibility of conversion reported at NAECON's big annual meeting; highlights from other papers presented

DAYTON, OHIO—The conversion of ground-emitted microwave energy for electrical power in space stations has been proved feasible.

This conclusion was presented by L. E. Porter of the Air Force's Wright Air Development Division (WADD) before the 13th National Aerospace Electronics Conference here recently.

Using state-of-the-art microwave tube technology, Porter said, converters have been built with efficiencies up to 32%. These were operated at 1290 mc with 240-kw peak input power. Work will continue, Porter asserted, to further increase efficiency. Also, more studies will be made to determine the variation of power and frequency, to investigate the feasibility of high-power continuous-wave operation, and to obtain a more complete understanding of the interaction phenomenon.

It is possible, said the WADD scientist, to envision a space platform powered by directed narrow-beam microwave energy. Indications are that even the present rf-to-dc (or low-frequency a-c) power converters can be improved readily to efficiencies of from 60-70%.

Investigations so far have shown that at least five different approaches for converters would be feasible: cross-field, linear-beam, plasma, cyclotron-resonance, and diode types. Only the crossed-field energy converter has been built and tested so far, Porter said.

(Much of the basic research in this field has been performed under an AF-WADD by Raytheon Company at its Microwave and Power Tube Division.)

• **Attendance low**—Fewer than 2000 persons attending the National Aerospace Electronics Conference (NAECON) gathered at the Biltmore and Miami Hotels for Dayton's annual 3-day technical spree.

The available 120 booths for exhibits were filled with over 70 major missile/aircraft electronics manufacturers.

A highpoint in this year's meeting was a classified session held at the Wright Field Auditorium. Five WADD experts presented a detailed look at the future role of electronics in military aerospace systems.

Moderator at the secret session was John Keto, WADD's chief scientist. Panelists and topics were B. Chasman—advanced electronics systems, Col. W. S. Heavner, USAF—reconnaissance trends, J. M. Ferguson—electronic propulsion, A. Goldman—advanced space systems, and H. Behrens—*Dyna-Soar* requirements.

• **Technical papers**—Roughly 100 papers were delivered at the 20 technical sessions. Among their highlights were the following:

—Velocity and range information along a radar-beam system with respect to terrain can be obtained simultaneously, said L. P. Schnepper of Raytheon's Missile and Space Division. It has been proven theoretically, he said, that such data can be collected with a single radar and interaction between the two portions of the radar signal can be prevented.

—The problems of successfully propagating radio energy through the ionized sheath enveloping hypersonic vehicles were outlined by R. Rawhouser, AF-WADD. A side problem limiting such studies, he said, is the difficulty in simulating the necessary environment in the laboratory.

Missile flights help, but they are too few. *Dyna-Soar* will be an effective instrument for obtaining valid data, but the information should be available to assist in the development of such a manned space vehicle.

Rawhouser described four approaches to reducing plasma effects on communications:

(1) Direct cooling of the vehicle region containing the antenna with water or steam injection into the boundary layer,

(2) Modification of shock region by gas injection into shock wave.

(3) Use of an electron beam and the plasma itself as the radiating element, or

(4) Use of a strong magnetic field to "guide" electro-magnetic energy through the plasma. The latter method appears most promising, the author said.

—An improved method for magnetohydrodynamic (MHD) gyroscopes was detailed by R. V. Monopoli, Speidel Corporation. The development of such a sensor, he said, was undertaken by his company's R&D Division on the basis of proposals by Dr. P. F. Maeder of Brown University. The author described an apparatus for measuring Coriolis forces using MHD methods.

The advantages of an MHD gyro, he said, are that they will avoid problems of mass unbalance and bearing friction and wear. ⌗

For Sea Surface Launching

HYDRA II MOCK-UP VEHICLE being readied by the Navy for personnel training and sea-handling tests. Mock-up missile is carried in amphibious R3Y vehicle used to transport on both land and sea. Hydras will be launched directly from an upright floating position in the water, with no pad or gantry required.

Transducer Field Demands Standards

Waste, high costs, uneven reliability and strain on vendor-customer relations plague industry today

by Harry N. Norton*

THE TRANSDUCER field today suffers from an accumulation of ailments curable only by a strong purgative.

The medicine—Standardization—is not new; the treatment is not painless. The remedy, however, can be extremely effective when administered forthrightly and without restraint.

The use of test instrumentation by the aircraft—and especially the missile and spacecraft—industry has been increasing at an extremely rapid rate during the past few years. The cost and complexity of the new vehicles and their operation require a maximum number of measurements to be made on a minimum number of ground and flight tests.

Measurement requirements have become steadily more difficult to meet with the transducer types available.

The expanding demand for new, reliable, accurate transducers of various types has brought about the creation of a multitude of new designs by established transducer manufacturers, as well as the entry of scores of new manufacturers into the aerospace transducer field.

Simultaneously, transducer users were faced with a manpower shortage in their many added instrumentation functions. A large portion of the vastly increased personnel engaged in various phases of transducer work therefore still lacks sufficient background, training and skill in this highly specialized field.

• **Diagnosis clear**—The existing sickness in the transducer field is rooted in three major problem areas: the user's uncertainty concerning actual measurement and environmental requirements; the user's confusion regarding optimum selection from a multitude of new transducers including many insufficiently tested designs; and the instrument maker's difficulties in attempting to satisfy the wide variations in transducer specifications.

The resulting duplication and waste of effort, high costs, doubtful reliability—as well as the strain on vendor-customer relations—have been extensively discussed in cognizant government and industry branches. Wherever solutions are being sought, a constantly recurring word is "standardization."

The desire for standardization is quite natural. Most fields of human endeavor, and particularly technical fields, reach a stage of development where agreement must be reached on terminology, performance requirements, and perhaps dimensions and general operating characteristics. Standards will usually originate at that point of the progress curve where this curve begins to flatten—i.e., where the ratio of past progress to future progress becomes large.

Standardization of some selected portion, aspects, or characteristics of a product can be helpful at an even earlier point on the progress curve. Recognition of the relative magnitudes of past and future progress is, of course, a primary prerequisite to choosing the time for initiation of standards.

• **Remedy safe**—To those familiar with the magnitude of recent progress in transducer development, it is quite clear that this time has now been reached in the case of certain general fundamentals and a limited number of specific transducer types.

Standardization can be started now—without fear of stifling future development—if the standards are kept flexible, if they are subjected to frequent revisions, if they are limited to high past-future progress ratio items, and if their possible complete obsolescence is borne in mind.

• **Terminology first** — Preliminary surveys by the Inter Range Instrumentation Group and by the U. S. Air Force's Aeronautical Systems Division have shown that the primary need for standardization of aerospace transducers exists in the area of terminology.

At the present time, many users and quite a few transducer manufacturers have their own glossaries or lists of definitions, each differing from any other on many terms. A few definitions appear in encyclopedias and glossaries published by technical organizations; however, most of these are too general, too academic, or too complex for acceptance by personnel at the working level.

The major portion of aerospace transducer work is performed on government-sponsored projects by personnel of varying education background, responsibility, skill and experience. It is not in the national interest to have terms they use defined in such a manner that they can be readily understood by only a few.

Simplified terminology must be developed, therefore, for the specific purpose of clearly defining performance parameters and some additional important fundamentals of aerospace transducers. Wherever possible the definitions should be no longer than one sentence. If necessary, only one of several general definitions should be selected if this serves the specific purpose under consideration.

Considerations of frequency of usage may show, for example, that many of the twenty-odd varieties of linearity (or non-linearity) may not have to be included in a simplified terminology standard. The conflicting usage of synonyms such as "input, stimulus, measurand" and "input, power, excitation" should be resolved to the inclusion of only one of these terms and cross-referencing the others to the one selected.

Nomenclature deserves particular, immediate attention. The main source for officially recognized names of government-procured items, the Federal Supply Handbook, lists only a "transducer, motional pickup" for physical measurements and seems concerned primarily with transducers as sources of acoustic energy.

It is difficult to guess that colloquial terms such as "strain gage," "pressure strain gage," "strain gage pickup," "bonded pickup," "bonded transducer," "pressure pickup" may all refer to a strain-gage-type pressure transducer. If a temperature transducer transduces temperature, does a "force balance transducer" transduce force balance? How many readers of instrumentation reports know that a "stick-on" is a surface temperature transducer?

*Mr. Norton is a senior instrumentation engineer concerned primarily with transducer development at Convair Division, General Dynamics Corporation, San Diego, Calif. Besides being a prolific author of technical articles and society papers, he currently is directing the nationwide government-user-vendor committee of the Instrument Society of America organized to establish transducer standards.

Unified nomenclature, acceptable to users, manufacturers and—particularly—cognizant government agencies, will have to be established in the very near future.

• **Performance specs next**—Specifications, especially those portions referring to performance characteristics, are some of the most potent sources of confusion to virtually all personnel in the areospace transducer field.

Misinterpretation of users' as well as vendors' specifications has already wasted thousands of man-hours and hundreds of thousands of dollars, according to very conservative estimates. While many of the past losses must be written off to the general learning curve, sufficient knowledge exists at this time to reduce greatly any further losses due to poorly-written specifications.

There can be as many interpretations of the meaning of "Accuracy: 0.5%, min." as there are people reading it. Tolerances for hysteresis may or may not include the sometimes very large eeffcts of statis friction in potentiometer-type transducers. Some specifications do not even mention vibration effects, others may omit numerical tolerances.

Line-pressure variation, not usually noted in specifications for differential pressure transducers, may cause errors in the order of 10% of full scale. "Frequency Response: flat to 2000 cps" is meaningless unless an amplitude error tolerance such as "within ±0.5 db from the amplitude at 100 cps" is added.

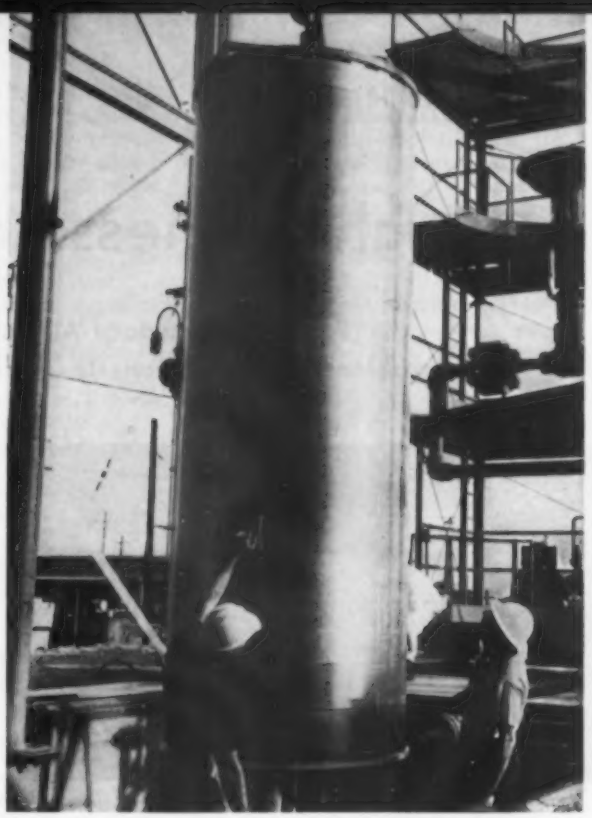
• **Testing weak**—Test procedures are closely connected with specifications. Improper test methods have defeated the purposes of many otherwise well-written specifications.

Performance characteristics can vary over a wide range depending on the method used for their verification; however, the lack of standard or at least mutually-agreed-upon test procedures has led to vendors' loss of business, users' embarrassment, multiple duplication of effort, and invalid data on vehicle performance.

Time-constant determination of temperature transducers may yield different data depending on viscosity, conductivity, and agitation rate of the liquid used for immersion. Vibration effects can appear to be very small if only d-c shifts are measured. In searching for temperature effects the stabilization time is quite critical. The number of measured points necessary for valid calibration data is a matter of great controversy.

Little consideration is given to preventing human errors. Data sheets may be difficult to interpret. Lengthy pages of comments can be used to make the importance of poor performance data seem negligible.

Glass Case For Polaris



EXPERIMENTAL POLARIS glass-wrapped motor is more than 14 ft. long with a 4.5-ft. diameter. Built by Aerojet-General, the motor is largest glass chamber ever fired. The case is part of the Navy's 2500-mile Polaris program.

Standard test procedures would offer an ideal solution to the dilemma in which minor users of transducers frequently find themselves, particularly if they lack adequate facilities. They are often faced with the choice of either trusting a specification or trusting an outside facility with performing a test per a sometimes loosely written procedure. Their problem may be aggravated by insufficient funds and their inability to evaluate test data properly.

The economic picture really does not look much better for vendors who are requested to write a different test procedure for each customer, and for major users who have to expand man-hours on evaluation of vendor-written procedures, on co-ordination with outside test facilities, and on possible re-runs of tests at their own facility.

The effectiveness of standard test calibration procedures could be increased by inclusion of readily available standard report blanks and data forms. Interpretation discussions and human errors may be minimized by enforced use of forms which are so designed that presentation of essential data is optimized when applicable columns and lines are filled in completely and affected blocks are checked off. Title pages of reports can become less decorative and more useful if they consist primarily of a summary table which simply shows what tests were either passed or failed.

• **Design problems**—In addition to terminology, nomenclature, specifications of performance characteristics, test procedures, and test reports, there are several design characteristics which could be standardized for a number of commonly used transducers with great benefit to both users and manufacturers. These include electrical connections and wiring diagrams, drawing symbols, nameplates, excitation requirements, fluid connections such as pressure fittings, and perhaps even selected mountings and configurations.

It may also be desirable, in the not-too-remote future, to create standard sheets for "preferred types," similar to "AN," "MS," or "NEMA" standards, with a "use-when-adequate" connotation.

• **Treatment difficult**—Standardization work on aerospace transducers will be a difficult but necessary task.

It will require wholehearted support from government agencies and the using as well as the manufacturing industries. It will demand concentrated and persistent effort from the limited number of instrumentation specialists whose background enables them to make substantial contributions to such a project. Essential to their work will be generous sponsorship by their employers.

The gains made possible by transducer standardization will soon become apparent in dollars and hours saved, improved data and better relations between manufacturers and users. The reduction in everyday hardware problems will facilitate work on new developments and help speed necessary improvements in the state of the art. ⠿

Weightlessness Lowers Performance

Tests at Aerospace Medical Laboratory foretell some problems for astronauts in maintaining tolerance to severe stress

PEERING EERILY from water tank, an Air Force subject tries various maneuvers in a condition simulating weightlessness.

PHYSIOLOGICAL changes occurring when muscles are not used for long periods of time are monitored by Capt. Graveline.

by Heather M. David

WEIGHTLESSNESS may lower man's stress tolerance even quicker than was previously thought.

A class of eight Air Force men who were submerged in water tanks in a simulated "weightlessness" condition found that some physiological changes occur as early as 6 to 12 hours.

Most important, the subjects did not perform as well on the centrifuge, tilt table and in heat tests after submersion as they did before. This may pose a real problem in spaceflight, when the pilot receives the greatest g forces and heat during re-entry.

Directing the tests at the Aerospace Medical Laboratory, AFSC, Dayton, Ohio, is a man who probably holds the record for the longest period of "weightlessness" at a stretch.

Capt. Duane Graveline, who last year spent a week in a water tank at the Brooks AFB Aerospace Medical Center, experienced significant muscular and skeletal deterioration towards the end of his ordeal. He even found walking a shaky experience when he finally emerged.

The Dayton group is trying now to pin-point when these changes occur and what man's exact needs are for exercise, sleep and food. The laboratory has just completed a 9 x 6.5 x 7 ft. tank which it is using for the tests.

The subjects recline on couches in the water with restraining straps to keep them from rising to the surface. Water temperature is kept at a pleasant 90-92°F, which the men feel as neither warm nor cold.

Electrocardiograms and electroencephalograms are taken by electrodes under the armpits and head of each subject. Air, food and water are supplied through tubes into the waterproof helmet, which is individually tailored to fit each man's neck.

Even the food is somewhat like a spaceman's provisions—semi-solids supplied from squeeze tubes.

• **Loss of strength**—The weakening process is marked by increased kidney activity, since calcium, phosphorus and other minerals leaving the bones and muscles are eliminated in urine. This increased output was noted even in short-term runs.

The researchers also found that this output could be decreased by exercising the subject and by the use of posterior pituitary hormones. Carefully designed exercises will be needed for periods of weightlessness lasting more than a few hours, most aerospace doctors agree.

Also noted in the current studies is a tendency to dehydration in the blood cells and an increase in blood hemoglobin concentration. The exact significance of this is yet to be determined.

Not yet under way at Dayton is a sleep evaluation program. A surprising thing emerging from Capt. Graveline's own experience was that he needed only about seven hours sleep in the entire week. Dayton doctors report that on the day-long runs they have noticed the subjects tend to fall asleep during the first few hours, then remain awake during the rest of the time.

• **Psychological studies**—Another important phase of the program is a battery of psychological studies on isolation and the effect of various forms of sensory input. Capt. George Barnard of the Aerospace Medical Laboratory head this project.

All eight volunteers have been carefully examined both physiologically and psychologically to get base-line measurements. Upon emerging, each subject recounts his feelings and thoughts to the psychiatrists.

Some of the subjects found the experience very exhiliarating. They hummed and whistled. When they got out of the tank they felt very bad and wanted to return.

The wildest hallucinations were experienced by those who had the least outside contact during their stay in the tank. One man even saw a rattlesnake in the water, but he was able to talk himself out of it. Others had trouble concentrating or remembering things. Some panicked when they awoke in the unnatural atmosphere.

And although spacemen may not have the luxury of television in their initial journeys, the Air Force is using it to find out how a man otherwise isolated reacts to this kind of stimulus. ⠿

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Missile Literature

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New Missile Products

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Other Information

GET ALL THE DETAILS . .

ABOUT ADVERTISEMENTS AND NEW PRODUCTS IN THIS ISSUE

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SUBSCRIBER SERVICE DEPT.

(Continued from page 17)

the State Department? Other government agencies are certain to be affected. What voice will they have?

• **Conventional legal problems**—Private companies that own or operate satellite communication systems will expose themselves to new kinds of legal liability. In the first place, they may become liable for personal injury and property damage caused by launching accidents or the flight or landing of satellites. Remember the recent fall of fragments from the vehicle of a *Transit* navigation satellite last November on eastern Cuba. Numerous incidents of this kind have occurred, and will certainly become more common as more and more satellites are launched from the earth's surface.

Manufacturers may be sued for damages resulting from defective parts. At an earlier stage of the industrial process, companies may be held liable for accidents that occur in the course of research and development, manufacturing, testing or handling. For example, rocket fuels are highly explosive, and may cause blast or fire damage. The operation of communication satellite systems may also involve other forms of liability arising from radio interference, libel or slander.

Such legal problems will be international as well as domestic.

Private companies that enter the satellite communication business may also run afoul of the antitrust laws. Should the government give a favored position to any one company? A favored position might become a monopoly if, as many people believe, only one communication satellite system could be run at a profit.

According to a letter of February 20, 1961, from the antitrust division of the Justice Department, "competitive considerations require that no one firm dominate satellite communications."

Some companies have proposed a "common carrier's common carrier"—that is, a joint venture providing service to all international communication companies desiring to use the channels of the system. It would also be possible for the Government to operate communication satellites just as it runs the Post Office.

• **Washington policy**—What is our present national policy concerning satellite communication systems?

Shortly before he left office, President Eisenhower stated that the Government should "aggressively encourage private enterprise in the establishment and operation of satellite relays for revenue-producing purposes." President Kennedy has not yet announced his policy, though he has said that this country would like to cooperate with the Soviet Union in several fields of space technology including satellite communications. Clues can be found, however, to the probable attitude of the Kennedy Administration.

The report to the President-elect of the ad hoc Committee on Space (the "Wiesner report") proposed that the Government set up a special organization to direct federal support of private space activities. This proposal evidently presupposes that space activities will be conducted by private enterprise, and will be directed and supported by the federal government. Furthermore, a staff report issued by the Senate Committee on Aeronautical and Space Sciences, formerly chaired by Vice President Lyndon B. Johnson, recently warned against "lending support to the image which often develops abroad—and which the Soviets would try to exploit—that any United States program of space relays would simply enrich the private communication interests."

The FCC and NASA have recently sanctioned the private development and operation of communication satellites. in a joint "memorandum of understanding" issued on March 15, 1961, the two agencies stated:

"In accordance with the traditional policy of conducting international communications services through private enterprise subject to governmental regulation, private enterprise should be encouraged to undertake development and utilization of satellite systems for public communications service."

The memorandum also referred to the "fact" that "at the present time overseas voice communications are provided primarily by a single company." The "single company" is AT&T, which operates the submarine telephone cables. In effect, this memorandum continues the Eisenhower policy favoring private communication satellites.

• **On our way**—In 1959 the International Telecommunications Union (ITU) allocated 6 radio frequency channels (in the 890-16,000 MC. range) for experimental space use, effective 1 May 1961. The ITU is scheduled to hold a special plenary session on satellite and other space communications in 1963. Observers predict that some foreign countries will not easily be persuaded to stop using certain frequencies in order to release them for space communications.

In 1960 the Federal Communications Commission (FCC) held hearings on frequency allocations for space satellites. Several private companies had asked for the reallocation of frequencies above 890 MC. for space use only. The FCC decided that "in view of present uncertainties, specific allocations for space communications cannot be made at this time" (FCC Report No. 751, September 29, 1960). The American Rocket Society has appealed from this decision to the U.S. Court of Appeals for the District of Columbia. Its petition for reversal states that the decision "vitally and adversely affected the allocation of radio frequencies for use in space activities."

In fact, a few frequencies (rather than broad bands) may prove to be sufficient for space use. Exclusive frequency allocations may not be necessary at all, except for services involving safety. There is a difference of opinion on this question, even among companies that plan to use communication satellites. True, a large number of low-altitude satellites may need exclusive frequencies. Earth-synchronous satellites, however, in 22,300-mile orbit, could probably share frequencies with land systems. (On the other hand, they would require very precise control as well as larger rockets than are now available.) Whether exclusive space frequencies must be allocated will thus depend on what kinds of communication satellites are eventually adopted.

Perhaps some firmer answers will emerge from the long-range FCC inquiry now being made into the frequency allocations required for space communications (Docket 13522).

In its decision of September, 1960, the FCC not only refused to set aside frequencies for space communications, but instead opened up frequencies above 890 MC. to private users for point-to-point communications on earth. Thus these vital frequencies would become available to banks, private shipping lines and other commercial companies. Commissioner T. A. M. Craven dissented, saying that the decision shows a "lack of long-range vision" and "fails to take into consideration the revolutionary effect which the future use of satellites will have on the lives of populations of the entire world, let alone citizens of this country, in terms of national and international communication, information and propaganda."

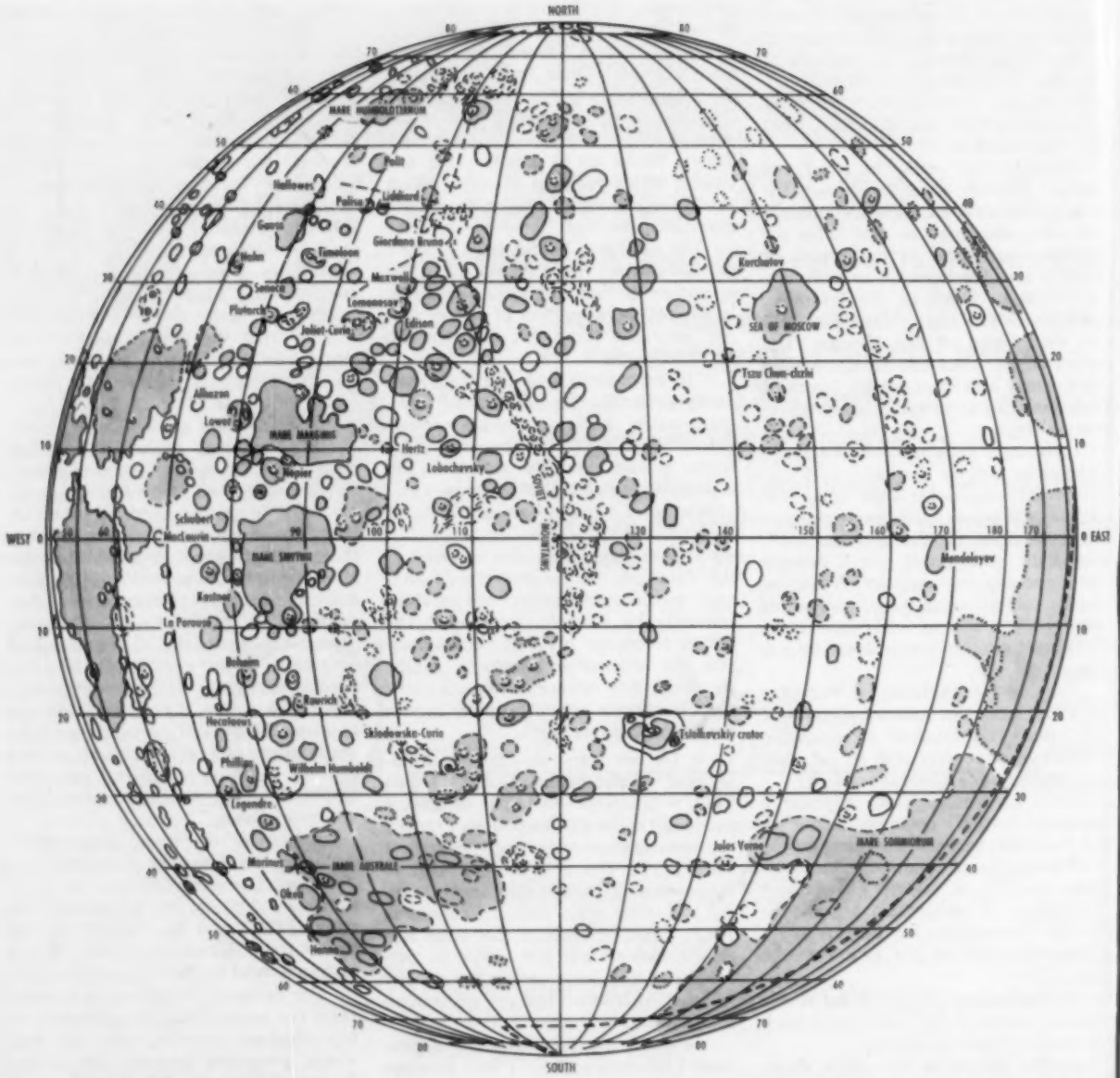
A number of private companies—including the American Telephone and Telegraph Company (AT&T), the International Telephone and Telegraph Company (IT&T) and the General Electric Company (GE)—have shown interest in commercial satellite communications.

For example, AT&T has announced plans for using some 50 satellites to relay telephone conversations and television programs between the United States and Europe. It is already designing a satellite, and says it could begin test transmissions within a year. The FCC has assigned two radio frequency channels to AT&T for this purpose (4100-4200 MC. and 6325-6425 MC.,

(Continued on page 53)

Details of first chart . . .

Russian Map Shows Moon's Fa S



Reliable formations with distinct outlines

Formations with less distinct outlines

Formations whose outlines require further revisions

Formations darker than surrounding background

Formations lighter than surrounding background

Light rays

Limits of visibility

Fa Side May Be Best for Landing

by William Beller

THE MOON'S far side may be the best place for lunar spacecraft to land.

At first sight, this pock-marked surface appears to offer cold comfort to craft seeking to come down on a firm, smooth terrain.

By contrast, the large seas and craters on the moon's near side seem to offer regions easy to negotiate and explore. However, if these seas and craters turn out to be areas of deep, talc-like dust, as some astronomers are predicting, then pontoon-type lunar craft will have to be used or a mountain landing accepted.

On the other hand, the Soviet map of the moon's far side shows no seas comparable in extent to those on the near side, and only one significant mountain chain. Thus, the far side may be hospitable to later landing craft. Early craft would not use the far side because they would lose communications with earth.

The admirable, but crude, map of the moon's far side is far from complete. Looking as though it had been sketched by an observer peering through fogged lenses, it picks up only blurred images of the terrain—and more often no images at all.

The western half of the map is by far the more reliable, particularly where the moon's librations have already given Soviet astronomers known moonmarks.

Here are some of the technical details behind the making of the map, according to a report by the Soviet's Academy of Sciences and other sources.

• **A two-eyed camera**—On Oct. 6, 1959, a twin-lensed camera mounted in Soviet spacecraft *Lunik III* shot pictures of the moon's far side for about 40 minutes. During this time, *Lunik III* was about 40,000 miles from the satellite's surface. Twelve days later, when the spacecraft was nearing its perigee, the pictures were televised from about 275,000 miles to Soviet ground stations.

Seventy percent of the moon's far side was photographed. To do this effectively, the Soviet camera took simultaneously and along parallel optical axes a series of pairs of small-scale and large-scale pictures. The diameter of the image of the lunar disk on the small-scale photographs amounted to about 10 mm, on the large-scale photographs about 25 mm.

The focal lengths and relative apertures of the two objective lenses in the camera were 200 mm and f5.6, and 500 mm and f9.5.

The Soviet report says that the camera saw the lunar disk illuminated the same way that an observer on earth would see the moon when it was nearly full. This means that the optical lenses of the camera almost coincided with the direction of the sun's rays, which lit up the lunar surface. Therefore the shadows on the moon were gone and the contrast between features was at a minimum.

The camera was loaded with specially prepared 35-mm photographic film, able to survive the trip and be processed under high temperatures. During the processing, the film was simultaneously developed and fixed and then washed and dried.

Processing for the two lens systems was done simultaneously. Thus, with a single orientation of the camera, features on the small-scale photograph which covered the moon's total disk could be correlated with details on the large-scale photograph.

When it was time to send the data down to earth, an electron-beam tube converted the negative images to electric signals by passing a light beam of constant brightness through the film. The beam moved evenly and slowly across the film; when it reached the edge, it returned rapidly to the initial position. While this motion produced line scanning, the vertical sweep was obtained by the slow and even motion of the film itself.

After passing through the film, the light beam fell on a photoelectric multiplier; its output was a voltage proportional to the varying transparency of the negative.

After amplification, the image signals modulated a high-frequency carrier and were transmitted to earth. To ensure that there would be no losses in fidelity due to the demodulation equipment, the Soviet scientists recorded the signals on magnetic tape both before and after demodulation.

Because the moon was shot at the worst possible time from a selenographic point of view—when the earth's satellite was shadowless and therefore two-dimensional—various methods had to be used to bring out the lunar detail.

One of the methods was the superposition of different frames. The Soviet reports that with strict superposition of several frames obtained under identical conditions actual features emerged more sharply, while the random noise was smoothed out.

Several types of superposition were used: simultaneous projection of several frames on a screen; projection of a positive on the positive print of another frame; and the production of "combined" prints from several negatives.

• **Amplifying a negative**—The Russian scientists say that the most fruitful method was that of "photometric sections." This allows photographic images to be selectively amplified.

For example, a zone on a negative is chosen for analysis. This zone covers a range of density contrasts and, therefore, of electrical signal amplitudes. A band of these signals is chosen to be amplified. Signals with amplitudes below the band necessarily come out black, and those above the band, white. All other signals are appropriately amplified and the images mapped.

This method permits wide amplification with relatively little noise. It is clear that the smaller the intensity range selected for conversion into an image, the larger the amplification factor that can be allowed. The largest factor the Soviet's instrument permitted was 100.

"The method of photometric section was found to be productive not only in identifying entirely unknown formations on the far side of the moon," the scientists claim, "but also in identifying formations located on the western edge of the surface of the moon visible from the earth."

The translation of the Russian report, called the "Atlas of the Far Side of the Moon," can be bought for $3 from the Office of Technical Services, U. S. Department of Commerce, Washington 25, D.C. ¤

international

Rat Flight Pr

French success proves that living animal can take high dosage of weightlessness & acceleration — brain action data being analyzed

FRANCE'S successful recording of a rat's brain activity under high g and weightlessness in a sounding rocket is expected to provide new data valuable in the effort to make manned space-flight safer.

The experiment last February proved a living animal can undergo weightlessness and acceleration to 12 g's with no ill after-effects—even a few hours after a grueling brain operation.

The rat nicknamed Hector, who performed the test aboard a *Véronique* rocket fired from Colomb-Béchar, will be exhibited this week at the Paris Air Show by the Air Research Medicine Center (Centre d'Etudes et de Recherches de Medicine Aeronautique —CERMA).

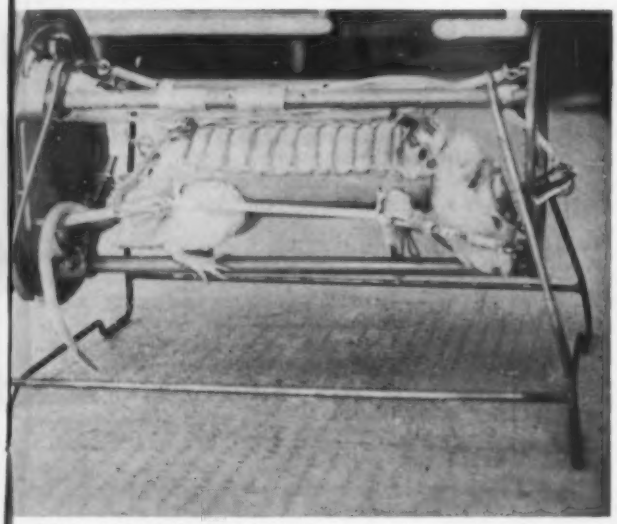
Surgeon General Grandpierre, who headed the CERMA experiment, told MISSILES AND ROCKETS that Hector was in fine health, has since fathered "petits rats" and provided needed knowledge of equilibrium and nervous systems reactions caused by weightlessness and by severe accelerations.

During a delicate six-hour operation preceding Hector's flight, holes were bored in his shaven skull to insert electrodes reaching the mesencephalic region and cortex of the brain. Other bipolar electrodes were placed in nape muscles of the neck and in the uppermost diaphragm cavity.

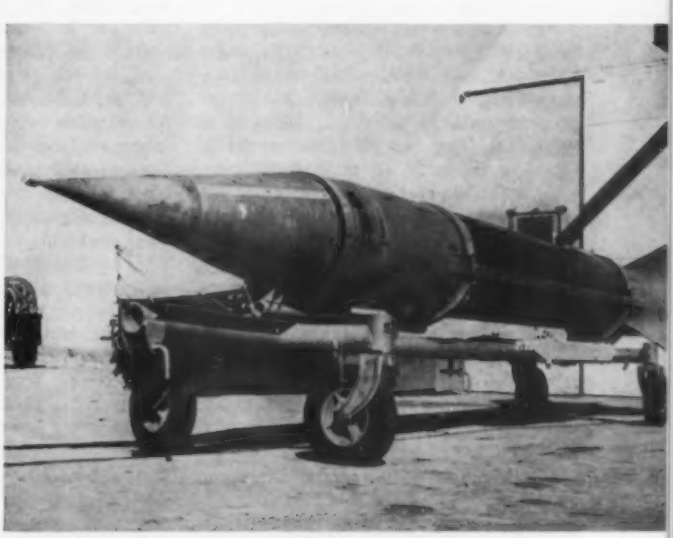
Scientists of the French National Academy of Science are studying telemetry data to parametrically analyze rhythm and brain consciousness.

"The preparation of the animal consisted, in effect, of embedding electrodes

Provides Data Encouraging for Man



HECTOR STRETCHES OUT in laced restraining frame in which he was put aboard the payload for the February firing. He is reported to be in excellent health and to have sired a family.



FRENCH VERONIQUE ROCKET of type used in Hector launch shown in horizontal position before erecting. The single-stage rocket, 24 ft. long, can carry total payload of about 132 lbs.

in selected brain positions and holding them there by special dental cement," Grandpierre said.

• **New plastic tested**—Parlaying other significance to the test, the French successfully tested a new plastic-based re-entry material by SUD Aviation and miniaturized instrumentation by the National Telecommunications Center (Centre National d'Etudes des Télécommunications—CNET).

The successful nose cone recovery terminated what may be the world's first attempt to electrically record and analyze brain waves in a space probe. The French freely admit it doesn't measure up to manned space exploits, but they hope "it will contribute to making existence during space flight safer." The final analysis is expected to be made available to foreign scientists.

SUD Aviation was called upon to develop nose cone material as shielding against temperatures ranging from −200°F to +300°F, since the flight plan called for a 135-mi. apogee, reaching Ionosphere "Layer F_1."

In a 4.6-cu.-ft. area, SUD and CNET had to install all the required electroencephalographic amplifiers, recorders and transmitters for the brain and nervous system studies.

On-board equipment recorder readings of accelerometers, internal and external temperature sensors, altimeters and vibration pickups. A new thermal valve principle was designed to maintain normal atmospheric pressure, and lithium hydroxide plates were installed to absorb excess carbonic gases.

The 2948-lb., 24-ft. *Véronique* has a normal 132-lb. payload capacity. Its single stage is fueled by a turpentine derivative with nitric acid oxidizer using furfurylic alcohol at ignition and liftoff. Acceleration and weight at burnout are 330 ft./s/s and 783 lbs.

• **Heart beat stops**—Apparently, the only modifications for this $200,000 experiment were in the nose cone area. The Hector flight was the fifth in a special series during which two of the earlier launchings resulted in explosions at the cradle.

Hector, in supporting vest and harness, was placed aboard at T-45 mins. As in most *Véronique* launchings, the gantry is rolled back at T-15 mins. and all technicians are recalled to the blockhouse. Initial acceleration was 66 ft./s/s and peak acceleration resulting from 49 secs. burning time put the rat through his paces at 12 g's.

A special timer sparked the detonation of explosive bolts for nose cone separation at T+5.1 mins., with the first chute, triggered at T+5.4 mins., slowing the descent to 197 ft./sec. A second chute maintained a 23 ft./sec. rate.

Throughout the flight, transistors amplified and transmitted the weak brain signals. Hector's heart stopped beating for about 10 secs., and all muscular reactions were suspended for almost a minute.

Although the nose cone did not penetrate beyond "Layer E," cosmic rays reddened the animal's white hair. ⌗

Joshua Produces Progress In High-energy Storable Fuel

EDWARDS AFB, CALIF.—The Air Force has just about completed initial work on its Project *Joshua*—a program of storable propellant development based on high-energy fuels.

Almost all of the project has been conducted as an in-house operation at the rocket propulsion test facility several miles across the dry lake from the Edwards Flight Test Center. Very little of the program has "gone outside" in any form.

Project *Joshua*, named after the trees which dot the Edwards area, came about in mid-1959, when applied research responsibilities in chemical rocket propulsion were switched, with some personnel, from Wright-Patterson AFB, Ohio, to Edwards. In picking up some loose ends, the high-energy storable propellant seemed promising, and engineers at Edwards decided to take a closer look.

The decision was made to use pentaborane, an outgrowth of the now-cancelled high-energy fuel program, and hydrazine. Pushing ahead despite resistance from some industrial quarters, the project staff designed and built hardware for *Joshua*, conducted its own tests and reduced its own data.

Fabrication requirements for some hardware required that the job be done outside, such as the Marquardt Corp. contract to fabricate the injectors.

First test runs with the propellant mix began in late 1959. Thrust levels of 5000 lbs. were achieved very early in the program and, to date, over 300 runs have been made at that thrust level and a specific impulse of 290 seconds has been achieved.

While the figure of 290 I_{sp} is not a spectacular one, it is very comparable with and, in some cases, exceeds that of current operational ICBM's. Ultimate goal, for which tests are just beginning is 40,000 lbs. of thrust with an I_{sp} of considerably over 300. The latter figure seems realistic in light of industry predictions that several pentaborane combinations will exceed 330 I_{sp} performance in a general time bracket of mid-1961 to 1962.

The 40,000 lb.-thrust program will continue to about July 1, then be cut off. It may be renewed in the future, however, pending certain developments the Air Force seems to expect. All components for the 40,000-lb.-thrust engine are in breadboard form—pumps, injectors and nozzles.

Engineers on the project are pleased with the results so far, but it has not been a smooth road. One major problem area was finding the proper injector design.

Original configuration incorporated a more or less standard injector face design. This led to quite a few splash plate problems. It was decided that the pentaborane/hydrazine combination needed something more unique. A shower-head system was tried without too much success.

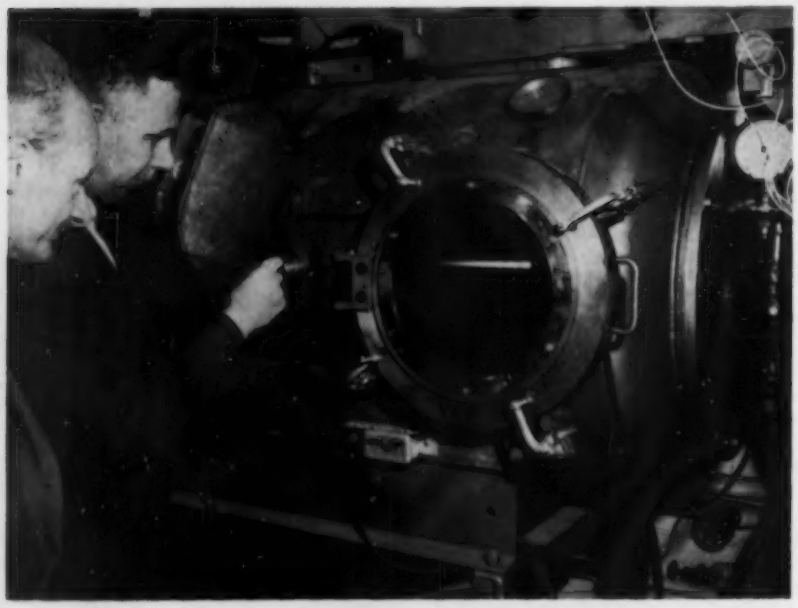
The current approach is not available in all details, but is reported to be a pre-combustion/cups type with a triplet pattern in each cup. But it has been shown that the propellant mix seems to demand mixing in the injector.

Wetting agents and additives were tried also to reduce the surface tension of the pentaborane. Some of these were successful to some degree, others not.

Typical problem, not a new one to propulsion engineers, was scale effect of an additive. The additive boosted performance between 5 and 6 percent in a 100-lb.-thrust test motor, but chopped between 1 and 2 percent from "normal" performance on the 5000-lb.-thrust motor.

One approach may be in pre-mixed additives. In one test a slug of N-204 was used for starting and motor output went up a couple of points when the N-204 system accidently stayed on rather than shutting off after the start.

A side effect of the *Joshua* Project is a program to jell pentaborane and hydrazine and perhaps add aluminum powder. This combination would increase engine performance and aid in safe handling of the mixture. ¤



Testing Avco's Arc-Jet Engine

ARC-JET ENGINE produces about one pound of thrust during 100-hour test-run in vacuum chamber. The 30-kw hydrogen engine is being developed by Avco for NASA and the Air Force as part of a study to determine the potential value of electrothermal propulsion for spaceflight applications.

Sperry Wins Big Contract For Ship Instrumentation

SPERRY RAND CORP. has been selected as prime contractor to instrument two C-4 vessels for use as Atlantic Missile Range tracking stations.

Twelve companies, or teams, submitted firm proposals in the heavy competition for the award. Value of the contract was not announced, but earlier estimates ran in the neighborhood of $50 million for the complete job. Final cost will be determined by negotiation.

Subcontractors have not been announced. However, the following firms were included in the Sperry bid team and will no doubt be among those named as subs: Ford Instrument Co. division of Sperry Rand, data handling and optical systems; Remington Rand Univac division of Sperry Rand, data handling; J. W. Fecker division of American Optical, optical systems; ITT Labs, communications, telemetering, data handling; Bethlehem Shipbuilding Corp., ship conversion.

Each 14,000-ton, 522-ft. ship will have a total crew of 130. ¤

Objections to Indemnification Plan

SPACE Administrator James E. Webb encountered sharp Senate questions last week when he asked for legislation that would allow NASA to indemnify contractors against unusually hazardous risks.

Webb told the Senate Space Committee the bill he proposed would give the space agency the same authority now enjoyed by the armed services.

Sen. Bourke B. Hickenlooper (R-Iowa) objected that under the bill the government would make good any loss suffered by a contractor because of its own negligence.

Webb and John A. Johnson, NASA general counsel, told the senators the contractors otherwise would buy commercial insurance against liability at a much higher rate than would be the cost if the government adopted the policy of self-insurance. They added that the cost of the insurance premiums is eventually reflected in the cost to the government.

Hickenlooper and Sen. Clinton P. Anderson (D-N.M.), former chairman of the Joint Atomic Energy Committee, noted that the proposed provision differs from the Atomic Energy Commission's indemnity law, which provides that contractors must obtain the maximum commercial insurance available to be eligible for government indemnity, which is limited to a maximum of $500 million for any one nuclear catastrophe.

Webb said NASA is covered, as an AEC licensee, whenever it uses nuclear materials. He said he would try to work out language closer to AEC's.

The measure would eliminate the Civilian-Military Liaison Committee and give NASA the same authority enjoyed by the armed services in settling claims against the government for past infringement of patents. In cost-type construction contracts, NASA would gain the same authority as the military services and the Coast Guard to waive performance and payment bonds.

Dr. Harold Brown, director of defense research and engineering, supported the proposal to abolish the CMLC. Both Brown and Webb said the Aeronautics and Astronautics Coordinating Board, established last fall, is working well. ⌗

mergers & expansions

SUMMERS GYROSCOPE CO. stockholders were asked to approve a name change to Guidance Technology, Inc., at their annual meeting in Santa Monica recently. Summers reported earnings of $150,717 for the fiscal year, an improvement over net loss of $753,514 the previous year. Sales totalled $10.9 million, compared with sales of $7.5 million the previous year.

GENERAL ELECTRIC CO. has acquired additional manufacturing facilities for fabrication and assembly of re-entry vehicles for the *Titan II* missile at its Burlington, Vt., operation. Research and development on the Mark 6 re-entry vehicle is being conducted at the company's Missile and Space Vehicle Dept., but production will start in Burlington when research activities are completed.

DELCO RADIO has begun construction of a 150,000-sq.-ft. manufacturing building for semiconductor products ot Kokomo, Ind. The building will be completed around May 1, 1962.

THE BENDIX CORP. Pioneer-Central Division will construct a Cryogenic Development Laboratory to be operated in conjunction with a liquid-oxygen research facility that the company has maintained for 18 years. The laboratory, to be managed by Dr. Thomas Flynn, will be used particularly for applied research and development of products involving the application of liquid hydrogen.

TRW COMPUTERS CO., division of Thompson Ramo Wooldridge Inc., and the Swartwout Division of Crane Co. have entered into an agreement to provide complete automatic control systems to the chemical, petrochemical and petroleum industries.

RADIO CORP. OF AMERICA has added 20,000 square feet of production area to its Needham, Mass., plant to manufacture complete memory systems and associated components for the electronic data processing industry.

NORTH AMERICAN AVIATION has added an electro-physical laboratory to its Space and Information Systems Division at Downey, Calif. The new laboratory will conduct advanced research in electronic emissions and related fields.

NORDEN DIVISION of United Aircraft dedicated its new multimillion-dollar research-engineering and manufacturing facility at Norwalk, Conn. The 350,000-sq.-ft. facility will house 1400 employees who formerly worked in leased buildings in Stamford, Bridgeport and Milford, Conn., and White Plains, N.Y.

financial

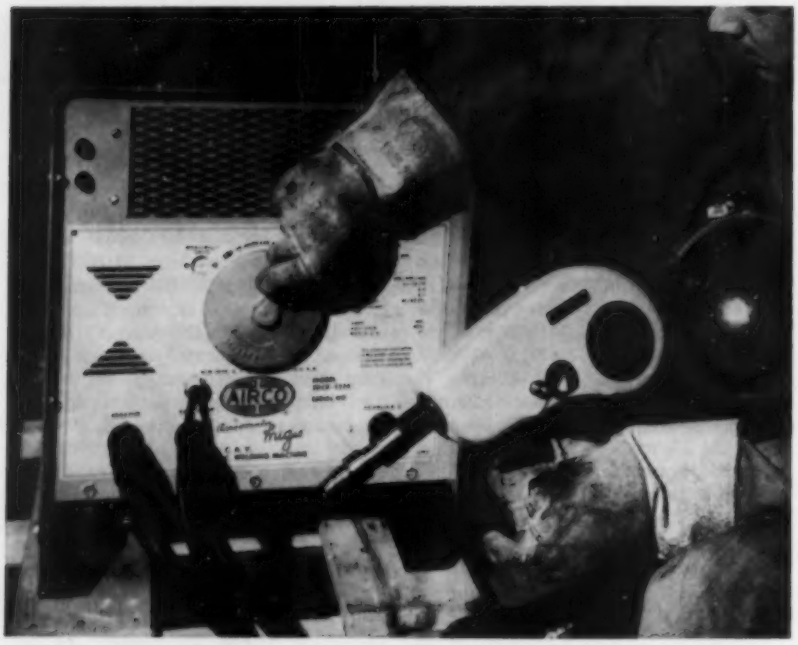
Marquardt Corp.—First 12-week period earnings were $159,240 on sales of $11.4 million, compared with 1960 earnings of $95,190 on sales of $14.1 million for the same period.

Clevite Corp.—Sales for the first quarter totalled $22.7 million, with earnings of $1.2 million. The same period last year saw sales of $26 million with earnings of $2.3 million.

McDonnell Aircraft Corp.—Earnings were $9.1 million on sales of $260.9 million for the nine months ended Mar 31, compared with $8.8 million on sales of $330.3 million for the first three quarters of fiscal 1960.

International Telephone and Telegraph Corp.—First quarter income rose 10% with a 9% sales and revenues increase. Net income was $6.6 million, compared with $5.9 million the first quarter of 1960. Sales were $193.6 million, compared with $177.8 million.

Minnesota Mining and Mfg.—First quarter sales rose to $139.7 million from $128.7 million last year. Earnings were $16.5 million, compared with $16.2 million the first quarter of 1960.



Gas-Shielded Metal Arc Welding Gun

A simple low-cost gas-shielded metal arc welding package is available from Air Reduction Sales Co. The complete package includes a Model AH20-E Aircomatic MIGet Gun and the MIGet CAV power source. The MIGet Gun connects directly to the power source, making operation extremely simple. A single control on the power source adjusts arc voltage while a handy knob on the MIGet Gun adjusts wire feed speed. Rated at 200 amperes DC, 60% duty cycle, the power source was designed especially for the 2.75-lb. Gun.

Circle No. 225 on Subscriber Service Card

Optical Polygon

A multi-purpose tool for optically checking alignment and angular spacing in any multiple of full degrees is available from Michigan Tool Co. Model MOX-3600 is a compact, high-precision indexing device with an optical mirror mounted on its rim. It is accurate to within 0.000012 in. at a 20-in. diameter. When used with an autocollimator or similar optical sighting device, the optical polygon provides an accurate mirror surface which reflects the projected image of the sighting device's cross hairs. The amount of deviation between the reflected image and the graduated cross hairs in the sighting device gives a geometric check on misalignment, parallelism and angularity.

Circle No. 226 on Subscriber Service Card

Transponder

A transponder which doubles the frequency of the signal received from the ground transmitter and transmits in the new frequency with sufficient power to permit reception at the ground station is available from Frequency Standards. The Doppler effect is utilized to determine speed and position of the vehicle. The unit receives on 37 megacycles and transmits on 74 megacycles. Input voltage is 5.5 to 10 V; output voltage 175 V ±2.5 V. Ripple does not exceed 0.5% of the output voltage. Bandwidth at half-power reference is not more than 6 kc and not less than 1.8 kc.

Circle No. 227 on Subscriber Service Card

Code Bar Switch

A code bar switch providing octal or decimal input, mechanical code conversion, and output by binary-coded contact closures is available from Computer Control Co. Conversion from octal or decimal digit to the corresponding binary code per digit can be achieved without resorting to the multiple relay contact arrangements. The DS Series has a full ten-button decimal bank with 1-2-4-8 binary output contacts. The OS Series has a seven-button octal bank with 1-2-4 binary output contacts.

Circle No. 228 on Subscriber Service Card

Sliding Latch Switches

Two styles of electrical pushbutton switches with sliding latches for padlocking are available from Mackworth G. Rees, Inc.

The switches are designed for low-cost stop lockout protection on a wide range of industrial applications—such as conveyor systems, automation lines, complex machine tools and other processes where multiple motor drives are used and/or where the motor controls are located at some distance.

Style 3829 has a single plunger, and

is normally furnished with one set of momentary transfer contacts. Style 3827 has two plungers—a start and stop button—in a single unit.

Circle No. 229 on Subscriber Service Card

Communications Towers

A line of two-way radio communications towers ranging in height from 10 to 500 ft. is available from Motorola, Inc. The line includes eight bolted or welded guyed towers and one self-supporting model. Five of the guyed towers are of bolted, tubular steel structure. Height of the smallest is 130 ft., while

the tallest can be raised to 440 ft. Two other guyed towers are constructed of welded solid steel cross-braces of tubular legs. The two units have maximum heights of 150 and 200 ft. Towers in all seven models have a windload rating of at least 30 psf. Possible antenna loads very from one antenna for the lightest models to five for the heaviest model. A heavy-duty bolted angular steel tower which can be raised to 500 ft. with 40 psf windload rating will support five antennas.

Circle No. 230 on Subscriber Service Card

Stable Amplitude Oscillator

A 1 cps to 100 kc stable-amplitude ultra-low distortion oscillator, featuring 0.01% amplitude stablity and 0.01% distortion, is available from Krohn-Hite Corp. Model 446 produces a pure sine wave that is continuously adjustable in frequency from 1 cps to 100 kc. Frequency calibration accuracy is within 1% from 1 cps to 10 kc. The unit is nearly free from "hum bounce" or line frequency beat — less than 0.05% — when operating near line frequency or hits harmonics.

Circle No. 231 on Subscriber Service Card

Cryogenic Thermometer

A completely integrated electronic cryogenic thermometer is available from Malaker Laboratories, Inc. The *Cryotherm* measures temperatures in the range of 0.3°K to 25°K. Measurements can be made readily without need for any special compensation and read directly on a calibrated scale to extreme accuracies.

Circle No. 232 on Subscriber Service Card

Shaft Encoder Translator

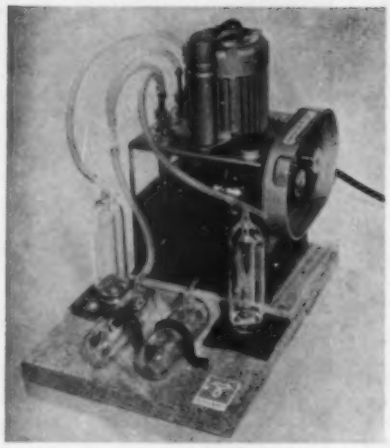
A shaft encoder translator designed especially for use in high-accuracy inductosyn systems has been developed by Harvey-Wells Electronics, Inc. The X116 is the final functional unit in a complex system containing four separate shaft position encoders. For each input angle—e.g., azimuth and elevation—there is a high-speed, high-resolution photo-electric encoder that converts the position of an inductosyn-driven secondary shaft into 13-bit binary gray code.

Every 180 degrees revolution of this secondary shaft corresponds to one degree of primary shaft revolution, which means that every two degrees of primary shaft revolution are quantitized into 8192 parts.

Circle No. 233 on Subscriber Service Card

Gas Mixing Pump

A gas mixing pump that provides various ratios of accurately measured gases for calibrating gas analyzing instruments over their entire range is being marketed by Instrumentation Associates, Inc.



The pump, which features an accuracy of ±0.05%, permits two or more gases to be combined in one mixture in in concentrations from 1 to 99%. As a result, it eliminates the necessity of storing many cylinders of various gas mixtures normally required when calibrating gas analyzing instruments.

Circle No. 234 on Subscriber Service Card

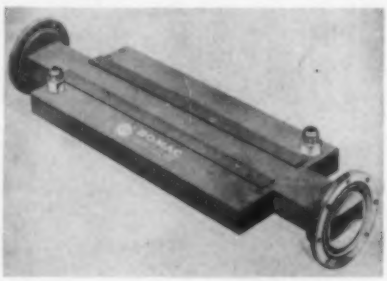
Filament Winding Machine

Narmco Research & Development Division of Telecomputing Corp. has developed a completely universal machine based on novel engineering principles and designed for filament-winding multi-shaped structural components. Designed to produce filament-wound structures of various sizes and configurations, the unit combines the operations of different filament-winding machines necessary for each basic shape. The unit's process parameters can be modified within a wide range, and shapes such as cylinders, sausages, spheres, ovaloids, cones, toruses and others can be wound within an envelope of 32 in. diameter and 90 in. length. Glass in single and/or multi-end configuration, wire or tapes may be wound, using wet or preimpregnated resin systems.

Circle No. 235 on Subscriber Service Card

Directional Couplers

Directional couplers being marketed by Bomac Laboratories, Inc., are available in three general configurations: cross guide coupling, sidewall coupling, and topwall coupling to meet the requirements of moderate cost, high-power handling capacity and high directivity, respectively. The units are available with customer specified coupling value, power handling capacities ranging from 70 to 2700 kw.



Circle No. 236 on Subscriber Service Card

RFI Measuring Equipment

Model NM-30A, a frequency-selective, calibrated VHF microvoltmeter and special-purpose receiver covering the RF spectrum of 20 mc to 400 mc with a constant impulse bandwith of approximately 200 kc, is available from Stoddard Aircraft Radio Co., Inc. NM-30A features I-F output for panoramic display; single-knob tuning; a 4½-in. two-decade logarithmic meter scale to aid the operator in the investigation, analyzing, monitoring and measuring of conducted or radiated RF energy.

Circle No. 237 on Subscriber Service Card

DC Power Supplies

Dynex Industries is marketing two high-efficiency miniature solid-state power supply units. Model PS 120 provides low voltages for transistorized circuits, strain gages, etc., with an input of 105-135 vac, output is 0-10 vdc, current 0-1 amp. Regulation is 0.002%

for 10% line voltage change and 0-200mA load current. Model PS 150 applicable to filament supply and computers provides 6.3 vdc, 5 amp. with input of 105-135 vac. Regulation is 0.05% for ±10% line voltage change, 0-5 amp. load. Both units suppress line transients in less than 10 microseconds, and include pushbutton reset with automatic overload protection. Under complete short circuit, the internal regulating transistor in each dissipates less than one watt.

Circle No. 238 on Subscriber Service Card

Data Link Antenna

A dual-pattern UHF data link antenna, Type 35500, with a single unit configuration, is available from Transco Products, Inc. The unit has dual radiation pattern coverage, controlled by a self-contained coaxial switch in the power divider and phasing network.

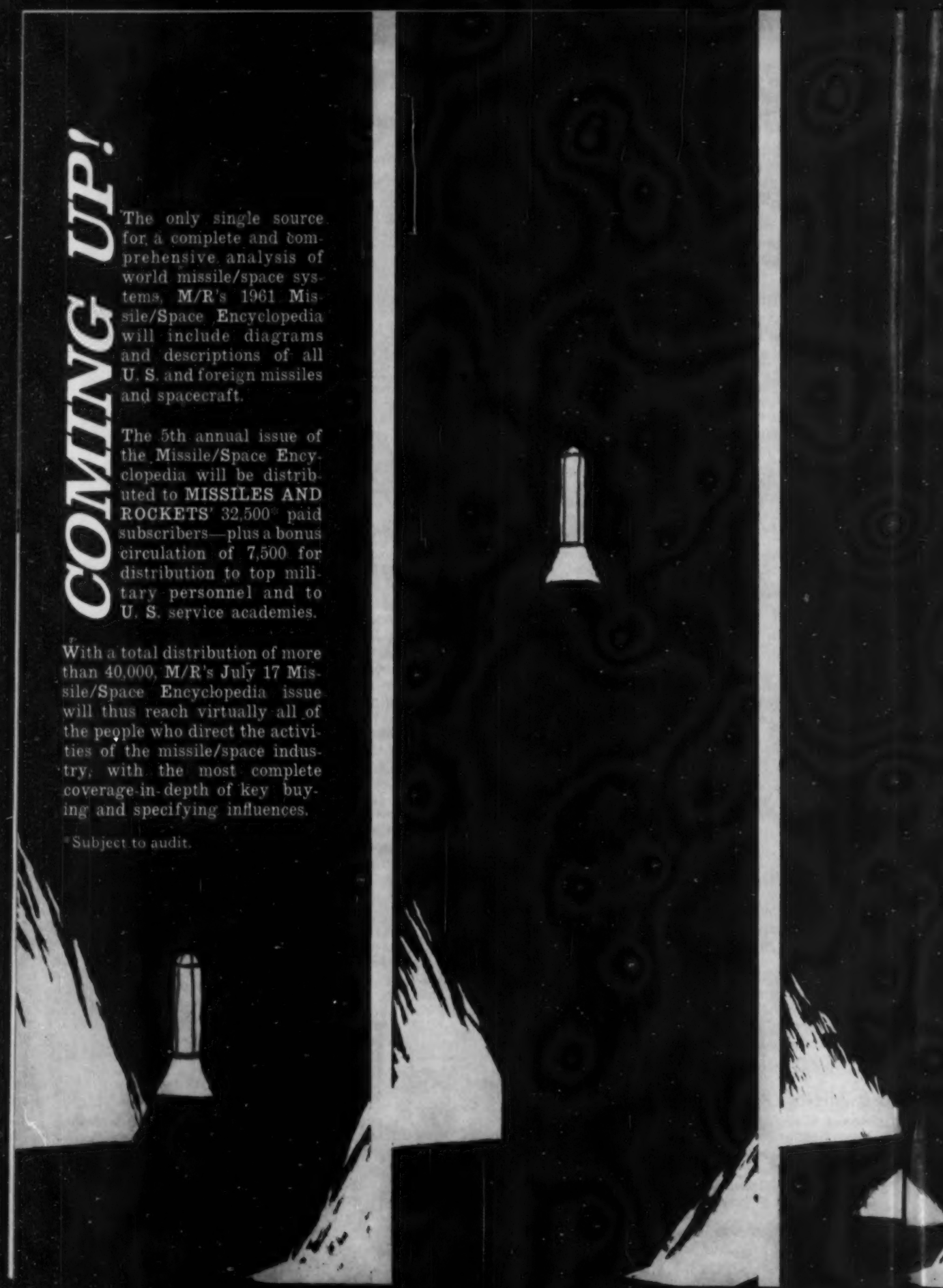
COMING UP!

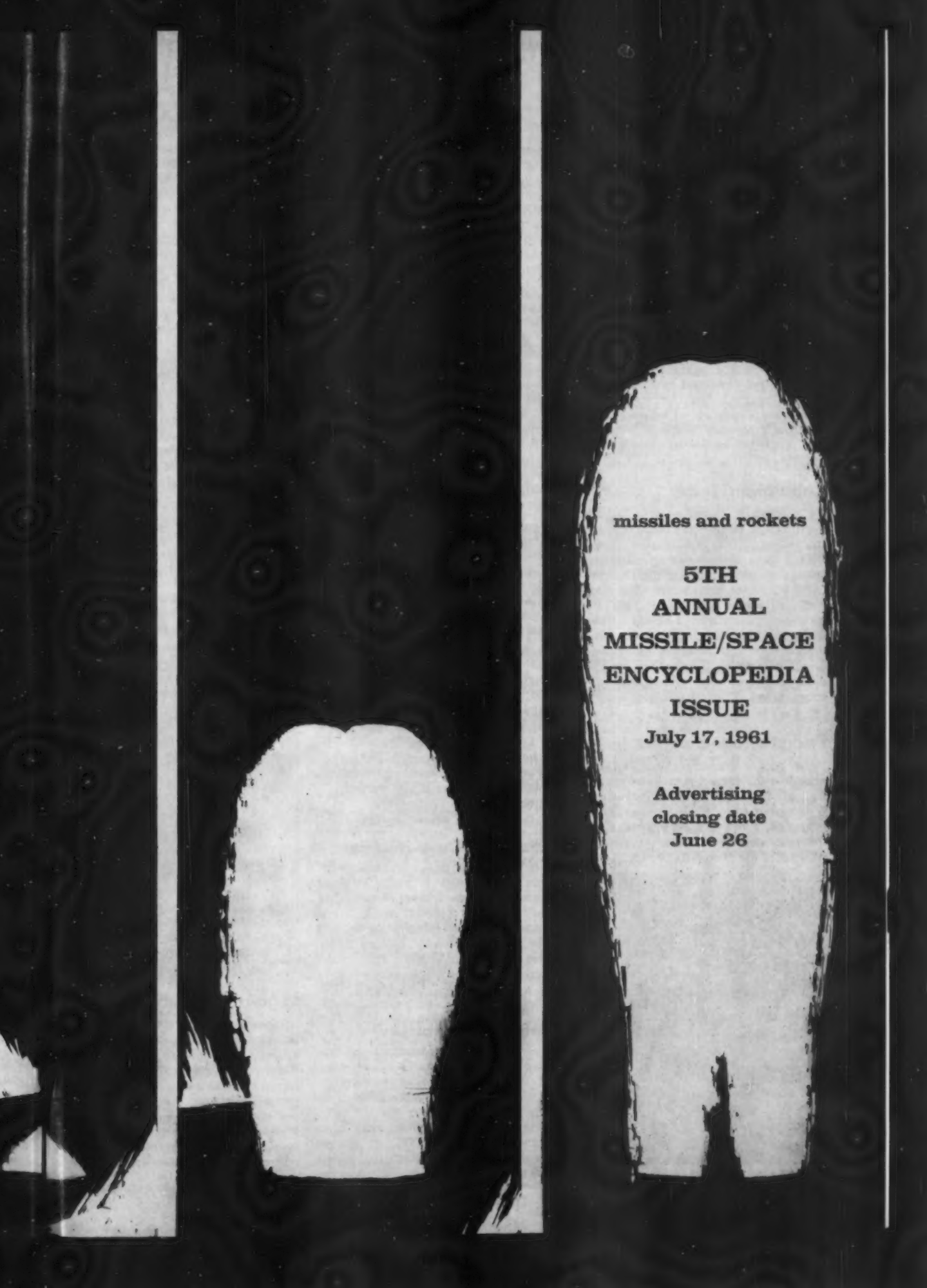
The only single source for a complete and comprehensive analysis of world missile/space systems, M/R's 1961 Missile/Space Encyclopedia will include diagrams and descriptions of all U. S. and foreign missiles and spacecraft.

The 5th annual issue of the Missile/Space Encyclopedia will be distributed to MISSILES AND ROCKETS' 32,500* paid subscribers—plus a bonus circulation of 7,500 for distribution to top military personnel and to U. S. service academies.

With a total distribution of more than 40,000, M/R's July 17 Missile/Space Encyclopedia issue will thus reach virtually all of the people who direct the activities of the missile/space industry, with the most complete coverage-in-depth of key buying and specifying influences.

*Subject to audit.




missiles and rockets
5TH
ANNUAL
MISSILE/SPACE
ENCYCLOPEDIA
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July 17, 1961
Advertising
closing date
June 26

With the switch solenoid de-energized, the radiation pattern is essentially omnidirectional in the azimuthal plane. In the energized position a cardioid-shaped radiation pattern occurs, producing a front-to-back ratio of −17 db or greater over the frequency range 225 to 400 MC. Polarization is vertical.

Circle No. 239 on Subscriber Service Card

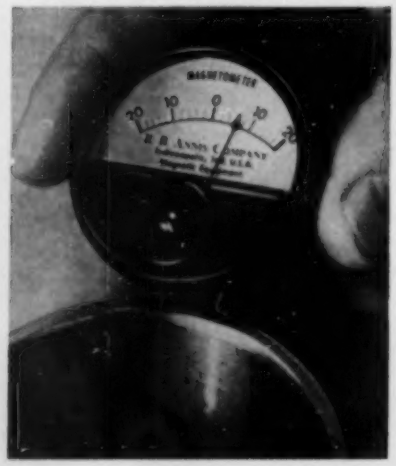
Calibration Tester

A compact, secondary standard test instrument is being produced by Howell Instruments, Inc. Calibration Tester BH153 is a direct reading adjustable voltage source, simulating the DC electrical output of transducers with a setting accuracy of 0.05%. The BH153 is matched to the curve of any DC transducer in either direct or indirect terms of reference and simulates the outputs of thermocouples, pressure transducers, differential pressure transducers and strain gages in any desired scale units.

Circle No. 240 on Subscriber Service Card

Pocket Magnetometer

A pocket instrument that instantly measures the degree of residual magnetism in steel tools, parts and structures is available from R. B. Annis Co. In operation, a red spot on the bottom of the magnetometer case is placed near or against the object to be tested. The pointer immediately deflects to a reading on the scale proportional to the magnetism in the part at that point. Magnetic polarity is indicated by the direction of pointer deflection on the center-zero, 20-0-20 scale.



Circle No. 241 on Subscriber Service Card

Frequency Comparators

The FC line of ultraprecision frequency and pulse rate comparators is available from Pioneer Magnetics, Inc. The unit is a completely static, self-contained precision detector which produces a DC voltage or current output whose polarity and magnitude depends in the difference in frequency between two input signals. Difference scale expansion ratios range up to as high as 10/1. Standard outputs available are 0-1 volt DC filtered, 0-5 volts DC filtered, 0-50 microamps filtered and 0-1 milliamps unfiltered.

Circle No. 242 on Subscriber Service Card

Compact Blower

A lightweight, compact, high-performance blower has been developed by Task Corp. The blower produces 277 ft.³/min. at 5.91 in. of water in a 4.29 in. duct. Basic tooling permits variations to approximately 1.3 times original design flow rate.

Circle No. 243 on Subscriber Service Card

Phil-Trol Relays

Two micro-miniature relays are being marketed by the Phillips Control Co. Type 30-22 features "Spade" terminal header and is equipped with two-stud "L"-shaped mounting brackets. Type 30-23 features a 90° printed circuit header.

Circle No. 244 on Subscriber Service Card

Perforated Tape Handler

A high-speed uni-directional perforated tape handler is available from Digitronics Corp. Dykor Model 4544 handles 500 ft. of 5 to 8-level tape interchangeably, at speeds up to 500 characters per second. The unit is designed to function with the Dykor unidirectional Model 3500 photo-electric tape reader.

Circle No. 245 on Subscriber Service Card

Timing Terminal Unit

A compact timing terminal unit providing increased versatility and reliability for missile-satellite test ranges and tracking systems is available from Vitro Laboratories.

An all-transistor miniaturized unit, designated Model 90,000, it receives remotely generated timing signal inputs and provides local timing signal outputs for telemetry recording, data processing and ancillary equipment. It is applicable wherever timing accuracy and synchronization are of paramount importance.

The Model 90,000 provides 60-volt pluses at 200 ma with less than a 5-microsecond rise time into a 0.1 mfd capacitance, driving up to 20 lines in various combinations of requirements.

Circle No. 246 on Subscriber Service Card

Be-Cu Strip

The Brush Beryllium Co. is marketing a mill heat-treated beryllium copper strip with tensile strength to 190,000 psi and formability exceeding all previous standards for this type of alloy product. Eliminating the need for customer heat treatment, these processes also thermally iron the material to a high degree of flatness and provide better uniformity throughout a coil and between lots.

Circle No. 247 on Subscriber Service Card

Waveguide Adapters

General RF Fittings, Inc. is marketing a series of waveguide adapters for use in the test laboratory, in the field or wherever a transition from coax to waveguide is needed. The units adapt coaxial cable to rigid waveguide through the use of either male or female TNC coaxial connectors and a short length of waveguide with a flange. Coaxial fitting mates with standard TNC connectors and waveguide mates with standard X or C flanges. Waveguide adapters are also available TM to waveguide.

Circle No. 248 on Subscriber Service Card

Logarithmic Amplifiers

Instruments for Industry, Inc. has introduced a line of logarithmic-response IF amplifiers that provide a linear output change from a logarithmic input change, and a normal detected output. The amplifiers provide clear readings, logarithmic in spacing, at all levels between the maximum and minimum readings of a specific input range.

Circle No. 249 on Subscriber Service Card

D-C Function Generator

A DC adjustable function generator is available from Vernistat Division of the Perkin-Elmer Corp. The function generator, an adjustable nonlinear potentiometer, provides a rapid means of generating any desired nonlinear output with shaft rotation of an associated interpolating vernistat. The DC adjustable function generator can program and control any process or operation which is a function of shaft position or time.

Circle No. 250 on Subscriber Service Card

new literature

ASW REVISION—A current updating of the reorganization of the Navy's Bureau of Weapons Anti-Submarine functions has just been published by Defense Information, Inc. In conjunction with its already published ASW Directory, the firm has brought its current listings and organizational functions up to date with the BuWeps revision. This revision is presently available only as part of the complete Directory Service which covers the Navy's entire ASW effort.

Circle No. 200 on Subscriber Service Card

FLUTTER—A study of the phenomenon of flutter and its associated disturbances: wow and drift, is available from Amplifier Corp. of America. Basic theory is followed by a discussion of flutter measurement, causes, avoidances; and anti-flutter maintenance. Graphs and photographs illustrate the text.

Circle No. 201 on Subscriber Service Card

HARDFACING—A 44-page brochure has been issued by Air Reduction Sales Co. on hardfacing electrodes and wires. The wear protection provided on industrial and construction equipment by Airco hardfacing alloys is discussed in detail. A description of each electrode is presented along with application data. Over 100 specific equipment parts that benefit from hardfacing are listed in an extensive section, together with the type of wear to which each is subject and the alloy needed to protect it.

Circle No. 202 on Subscriber Service Card

VACUUM TECHNOLOGY—A catalog of high-vacuum technology and products has been published by the Vacuum Products Division, Varian Associates. The catalog contains technical descriptions of VacIon® pumps in sizes ranging from 0.2 liter/sec to 10,000 liter/sec; a brief explanation of the pump operating principle; and a list of VacSorb® pumps, power supplies, high-vacuum valves, control units, argon-stable Super VacIon® pumps, basic and special vacuum systems and accessories.

Circle No. 203 on Subscriber Service Card

contracts

NASA

$81,426—**Aro Cryo-Sonics, Inc.**, Los Angeles, for pump and vaporizer

$74,580—**Compudyne Corp.**, Hatboro, Pa., for services and materials for designing, furnishing and installing airstream oscillating system.

$42,000—**Space Electronics Corp.**, Glendale, Calif., from Jet Propulsion Laboratory of Calif. Institute of Technology, for development, fabrication and testing of frequency multiplier subassemblies.

$33,238—**King-Knight Co.**, San Francisco, for vacuum system alteration for hypervelocity ballistic range at Moffett Field.

$29,070—**B&F Instruments, Inc.**, Philadelphia, for recording system, strain gage for Lewis Research Center.

NAVY

$36,000,000—**General Electric's Heavy Military Electronics Department**, Syracuse, N.Y., for AN/SPS-30 long-range, height-finding radar for use on missile cruisers and carriers.

$1,016,267—**Raytheon Co.**, Lexington, Mass., for continued component development for the *Polaris* missile guidance system.

$521,249—**American Bosch Arma Corp., Tele-Dynamics Div.**, Philadelphia, for design, development, and production of underwater battery missile switching system.

$228,399—**Walker Electrical Co., Inc.**, Atlanta, for missile fire control switchboard for *Subroc* missile system.

$185,000—**Hoffman Electronics Corp.**, Los Angeles, from **Applied Physics Laboratory, Johns Hopkins Univ.**, for solar power supplies for a forthcoming series of *Transit* satellite experiments.

$160,000—**Collins Radio Co.**, Cedar Rapids, Iowa, for additional airborne ultrahigh frequency communication equipment.

$39,247—**Raytheon Co., Aero/Weapons Div.**, Waltham, Mass., for necessary services, labor and material to fabricate gyros.

ARMY

$7,875,000—**Fairchild Engine & Airplane Corp.**, Hagerstown, Md., for three long-endurance, multi-purpose drone systems AN/USD-5 (XE-2).

$556,782—**Sperry Rand Corp.**, Salt Lake City, Utah, for repair parts for the *Sergeant* guided missile system. (Three contracts.)

$246,298—**Electro-Optical Systems, Inc.**, Pasadena, Calif., for research and development program on base flow.

$225,184—**Nortronics**, Anaheim, Calif., for engineering services and repair parts for the *Hawk* missile system. (Two contracts.)

$113,552—**Nortronics**, Anaheim, for wing assembly for guided missiles.

$72,474—**Western Electric Co.**, New York City, for *Nike* replenishment spare parts.

$64,000—**Adler Construction Co.**, Hialeah, Fla., for addition to the SAGE structure at Richmond NAS, Dade County, Fla.

$37,054—**Landers, Frary and Clark**, New Britain, Conn., for radiation monitor system with auxiliary equipment for *Titan II* missile launch facilities.

$36,618—**Western Electric Co.**, New York City, for installation of modification kits for *Nike* missile system.

$32,330—**The Martin Co.**, Orlando, Fla., for finalization of engineering orders for the *Lacrosse* missile.

$32,606—**Douglas Aircraft Co.**, Santa Monica, Calif., for *Nike* replenishment spare parts.

$30,649—**Douglas Aircraft Co.**, Santa Monica, Calif., for low-bed trailer for guided missile.

$26,288—**Delta Electric Construction Co., Inc.**, San Antonio, Tex., for data link facilities and improvements for *Nike-Hercules* facilities, Dyess AFB Defense Area.

AIR FORCE

Electro-Mechanical Research, Inc., Sarasota, Fla., multimillion-dollar contract from **Boeing Co.** for development of the test instrumentation subsystem for the *Dyna-Soar* manned space glider.

$10,000,000—**General Electric's Missile and Space Vehicle Dept.**, Philadelphia, for development and procurement of 47 target missiles for *Nike-Zeus*.

$3,226,000—**Communication and Data Systems Div. of Collins Radio Co.**, Dallas, from **International Electric Corp.**, Paramus, N.J., for data transmission equipment for use in system to be installed for the Strategic Air Command.

$2,800,000—**Kollsman Instrument Corp.**, New York City, for celestial guidance ground support equipment.

$2,000,000—**Armour Research Foundation of Illinois Institute of Technology**, Chicago, for examination of all military electronic devices for possible mutual interference.

$841,500—**Motorola's Semiconductor Products Division**, Phoenix, Ariz., for research on new methods of encapsulating semiconductor devices.

$600,000—**California Eastern Aviation, Inc.**, Washington, D.C., for airborne countermeasure device (ALE-20) for the B-52H *Skybolt* missile bomber.

$450,000—**United Control Corp.**, Seattle, from **Boeing Co.**, for temperature control equipment for use in connection with silo-based *Minuteman* missiles.

$105,600—**Aerojet-General Corp.**, Azusa, Calif., for thrust chamber assembly and injector.

$103,060—**Dunn Engineering Corp.**, Cambridge, Mass., for equatorial turntable.

$95,585—**Space Technology Laboratories, Inc.**, Los Angeles, from Rome Air Development Center, for study of the use of an electronic device for generating electromagnetic radiation; $66,000 from Rome Air Materiel Area, for ground readout equipment units.

$95,236—**Rescon Electronics Corp.**, Waltham, Mass., for design, fabrication, installation and testing of a solid-state radar data processor.

$93,560—**Hughes Research Laboratories, Div. of Hughes Aircraft Co.**, Malibu, Calif., for services and materials for one year leading to development and construction of a solid-state maser amplifier and closed system refrigerator.

$65,502—**Bendix Corp.**, Baltimore, for design and fabrication of rocketsonde as a payload for a rocket sounding system.

$65,000—**Waltham Laboratories of Sylvania Electronic Systems**, from Rome Air Development Center, for development of mathematical procedures for reliability prediction of future electronics systems and system components.

$59,050—**Electro-Optical Systems, Inc.**, Pasadena, Calif., from Office of Scientific Research, for plasma propulsion research using electrically exploding wires or thin metallic films to generate the plasmas.

$45,000—**Goodyear Tire & Rubber Co.**, Akron, Ohio, from the **Boeing Co.**, for design and development of the main landing gear for the *Dyna-Soar*.

names in the news

SNAPP

TORIAN

COLLINSWORTH

BROWN

GALE

Vice Admiral William F. Raborn, Jr.: Director of Special Projects, U.S. Navy, will be presented with the Robert J. Collier Trophy for directing the creation of the *Polaris* missile weapon system during 1960. The trophy is given annually by the National Aeronautic Association under the sponsorship of *LOOK* magazine "for the greatest achievement in aeronautics or astronautics in America, with respect to improving the performance, efficiency or safety of air or space vehicles, the value of which has been thoroughly demonstrated by actual use during the preceding year."

Frederick J. Seufert: A director and former executive vice president and director of engineering, elected president of U.S. Science Corp., Los Angeles. **H. V. Brantly:** Former director of marketing, promoted to vice president.

Dr. William R. Laidlaw: Appointed manager of the advanced systems department at North American Aviation's Space and Information Systems Division, Downey, Calif., where he will be responsible for advanced aerospace system studies in both military and non-military categories.

Roy B. Snapp: Appointed divisional vice president of American Machine & Foundry Company in charge of its Washington office. Prior to joining AMF, Snapp was secretary of the U.S. Atomic Energy Commission.

H. Edward Rice: Named vice president-operations of Philco's Government and Industrial Group, Philadelphia. Prior to joining Philco, Rice was manager of manufacturing for GE's Light Military Electronics Department, Utica, N.Y.

Harry A. Sosnoski: Appointed manager, planning for defense electronics products, Radio Corporation of America, New York City. Previously he was director of product development for the Energy Division, Olin Mathieson Chemical Corp.

Henry W. Vogtmann: Promoted to senior test engineer for systems and components, **T. S. Torian** to director of contracts and planning, for the Bendix Corp.'s Mishawaka Division in Indiana.

Leslie J. Cook: Former manager of West Coast operations for the Perkin-Elmer Corp., joins Electro-Optical Systems, Inc. as manager of the Fluid Physics Division, Pasadena, Calif.

C. L. Burton: Promoted to development manager for aerospace and military equipment for the Aluminum Company of America, Cleveland.

Even T. Collinsworth, Jr.: Elected president and chief administrative officer of Fansteel Metallurgical Corp., North Chicago, succeeding **Dr. Frank H. Driggs,** who was elected chairman of the board.

Dr. William H. Clohessy: Prominent physicist, appointed director of research in the Advanced Program Department in a major expansion of The Martin Company's space research and development program in Denver. Dr. Cohessy's team will be responsible for research and theoretical studies anticipating the requirements of space and weapon systems of the future.

Joseph Butensky: Appointed assistant to director, Defense Systems Department, Servo Corp., Hicksville, L.I., N.Y., serving as coordinator between field personnel and Hicksville-based engineering and manufacturing divisions. **Frank J. Kocsis** transferred to this department to serve as New York area field engineer and infrared specialist.

James P. Brown: Former vice president and general manager of Astronics Division, promoted to vice president and corporate director of marketing of Lear, Inc., Santa Monica, Calif.

Dr. I. H. Swift: Appointed director of Information Systems Laboratory at North American Aviation's Space and Information Systems Division, Downey, Calif. Prior to joining NAA, Dr. Swift was assistant director of Hughes Research Center's infrared laboratory.

Dr. F. E. Brooks, Jr.: Former director of research and development, elevated to senior scientist for Temco Electronics Division of Ling-Temco Electronics, Inc., Dallas. **William A. Tweedie** has been promoted to vice president and general manager of Ling Electronics Division.

Robert F. Ward and **Joseph B. Heimann:** Elected vice president-precision components group and avionics group, respectively, of the Kearfott Division of General Precision, Inc. and **Thomas J. Thomas,** former general manager, computer and control, promoted to vice president in charge of computer and controls and power equipment.

A. R. Gale: Vice president of Ampex Corp., elected a director of Controls Company of America, Chicago.

Dr. Luke Harvey Poe, Jr.: Former director of the Physics and Chemistry Laboratory, St. John's College, named assistant to the president of Aerojet-General Corp., Azusa, Calif.

Allen S. Dunbar: Named manager of space flight activities at the Maryland Division of Litton Systems, Inc. Dunbar will direct scientists and technicians who are engaged in reducing data obtained from satellite and space probe programs. Before joining Litton Systems, he was chief of electronics research for Convair, San Diego.

Dr. Clayton F. Black: Joins the systems research staff of The Bissett-Berman Corp., Los Angeles, with the missile defense and related space program activities of the corporation his principal interest. Formerly Dr. Black was active in Loral Electronics programs for development of ballistic missile space concepts and space system studies.

Richard P. Gifford: Manager of the Communications Products Dept., General Electric Co., Lynchburg, Va., appointed a member of the Joint Technical Advisory Committee to fill a vacancy left by the recent death of **Dr. John V. L. Hogan.** JTAC is sponsored by EIA and IRE and is currently making a special study of frequency allocations problems in space communications for the FCC.

Communications

(Continued from page 39)

both common carrier frequencies). GE plans to use 10 relay satellites in conjunction with 19 ground stations. IT&T will soon begin moon-bounce communication experiments with England. It has recently received an FCC license for experimenting with passive relay satellites. The frequencies assigned to IT&T are 2299.5 MC., previously allocated by the ITU for space research, and 2120 MC. (until July 1, 1961 only), a common carrier frequency.

On March 1, 1961, the Radio Corporation of America (RCA) urged the Government not to give any one company a preferred position. It favored satellites owned and operated by a group of companies, and "open to full and independent access" for all international communications. In its brief, filed with the FCC, RCA disclosed that it was considering a joint venture with Lockheed Aircraft Corporation and General Telephone and Electronics Corporation to develop and operate a communication satellite system as a service to all carriers." According to its plans, an experimental satellite will be launched within a year. When the system becomes operational, "circuits will be made available to other communications common carriers for use in their business if they desire."

NASA has asked Congress for a total of $68.6 million—24 million during the current fiscal year and 44.6 million for next year—to develop communication satellites. According to NASA plans, about $50 million of this amount will be used to develop a commercially adaptable active system (Project *Relay*.)

The Department of Defense is spending some $50 million a year on communication satellites, and will soon be spending much more.

Nor are such developments confined to the United States. Eventually they are bound to involve every nation on earth.

At present, it is true, the United States appears to stand alone in this field of space technology. The Soviet Union has not made any known experiments.

Other advanced countries, however, are already planning programs for satellite relays. British interest is especially keen. In late 1960, a team of British experts visited Washington for talks about communication satellites.

According to a New York Times dispatch of December 29, 1960, "The House of Commons was recently told that astronomical profits would accrue to the American Telephone and Telegraph Company under a communications system using satellites. . . . Behind both the (British) Government program and the criticism of it by Tory backbenchers lies a desire to compete with the United States in world-wide communication systems based on satellites."

The government-owned telephone agencies of Great Britain, France and West Germany have expressed interest in establishing an international space communication system linking the United States and Europe.

Ten European nations have recently formed a "space club," tentatively known as the European Space Research Group. Member nations are Belgium, Denmark, France, Italy, the Netherlands, Norway, Spain, Sweden, Switzerland and the U.K. One of the first objectives of the Group is a communication satellite system.

Evidently the age of space communications is no longer a distant prospect. It has nearly arrived. When it comes, it will have the same kind of impact on our lives as the inventions of the telephone and the radio. ⌗

—when and where—

MAY

ARS National Telemetering Conference, Sheraton Towers Hotel, Chicago, May 22-24.

Fifth Global Communication Symposium (Globecom V) and National Telemetering Conference, sponsored by American Institute of Electrical Engineers, Institute of Radio Engineers, Institute of the Aerospace Science and Instrument Society of America, Sherman Hotel, Chicago, May 22-24.

Design Engineering Show, Cobo Hall, Detroit, May 22-25.

Society of Automotive Engineers, Military Ground Support Equipment Committe, Continental Hilton Hotel, Mexico City, Mexico, May 23-25.

Electronic Industries Association 37th Annual EIA Convention, Pick Congress Hotel, Chicago, May 24-26.

Operations Research Society of America, Ninth Annual Meeting, Sheraton-Blackstone Hotel, Chicago, May 25-26.

First National Conference on Peaceful Uses of Space, sponsored by National Aeronautics and Space Administration and the Tulsa Chamber of Commerce, Tulsa State Fairgrounds, Tulsa, Okla., May 26-27.

Chemical Institute of Canada, Forty-fourth Annual Meeting, Ottawa, Canada, May 29-31.

7th Annual Radar Symposium (SECRET), University of Michigan, Institute of Science and Technology, Ann Arbor, May 31-June 2.

JUNE

National Machine Tool Builders' Association, 59th Spring Meeting, Mayflower Hotel, Washington, D.C., June 1.

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editorial . . .

Lessons from the Labor Hearings

THE STORY of labor troubles which have delayed construction of U.S. missile and space bases is a sordid one. That story is written into the record of the Senate's Permanent Investigating Subcommittee. It should not be overlooked.

The figures are of such a magnitude there is danger they may be greeted as just another column of statistics. But take a careful look at them. The subcommittee was told that during the past 4½ years there were 327 strikes at 22 missile bases. Lost time from these totals 162,000 man-days of work.

Our missile and space programs are at least six months behind schedule as a result. Yet a prominent union official, C. J. Haggerty, president of the AFL-CIO Building Trades Department, tried to convince the McClellan subcommittee that strikes were a minor factor in base construction delays.

Testimony before the subcommittee indicates otherwise.

Without question, the concurrency concept of building missile bases with the missiles themselves still under development led to an unexpectedly large number of change orders, contributing to the lag. But this fact itself should have instilled an even greater sense of urgency in the program.

Instead, the picture drawn before the subcommittee was one of jurisdictional disputes, make-work practices, exorbitant wages and low productivity. As a taxpayer, you have been taken for an expensive ride by some of your fellow Americans. The story of the construction worker drawing a larger weekly salary than the Secretary of Defense already has been widely reported.

B. G. MacNabb, Convair's operations chief at Cape Canaveral, testified that production on construction jobs at the Cape was about 40% of the rate civilian industry would require.

Blame for this must be shared by the government officials and contractors who condoned the practices. Firmer management would have cut sharply into the delays and saved the nation literally millions of dollars.

The question has been raised whether the subcommittee is flogging a dead horse, since most of the damage to the *Atlas* and *Titan* programs has been done.

Work of the McClellan group already has had several beneficial effects, however. Once the investigation began, labor troubles at the Cape dropped off sharply. With the subcommittee in session, contractors at Canaveral instituted several procedures for greater efficiency which probably would have led to walkouts earlier.

"The best thing the subcommittee could do for us would be to stay permanently in session on this problem," commented one program manager.

DISCLOSURES before the subcommittee also needled the Department of Defense into action. The practice of standing aloof from labor problems, certainly an absurd posture in programs of such urgency, was reversed. The Air Force was ordered to halt any wasteful labor-management practices in base construction. President Kennedy and Labor Secretary Goldberg also have indicated they plan to act.

With this backing, contractors can deal more firmly with the unions.

Testimony in the hearings revealed a number of expensive labor practices which already are beginning to gnaw at the *Minuteman* program, particularly in the Montana area. It is perhaps too late to do much for the *Atlas* and *Titan* programs, but the government should move promptly to keep labor costs on the new missile and space programs well in hand. A good place to start would be with a careful reading of the testimony presented on the Hill.

The good work of the McClellan subcommittee should not be wasted.

William J. Coughlin

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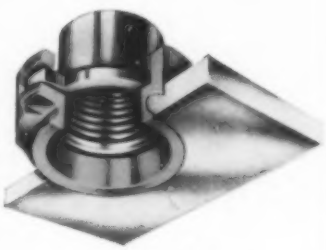

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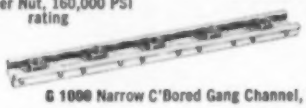

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